THE ELECTRICAL WORLD

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The Exhibit of the American Electrical Works.

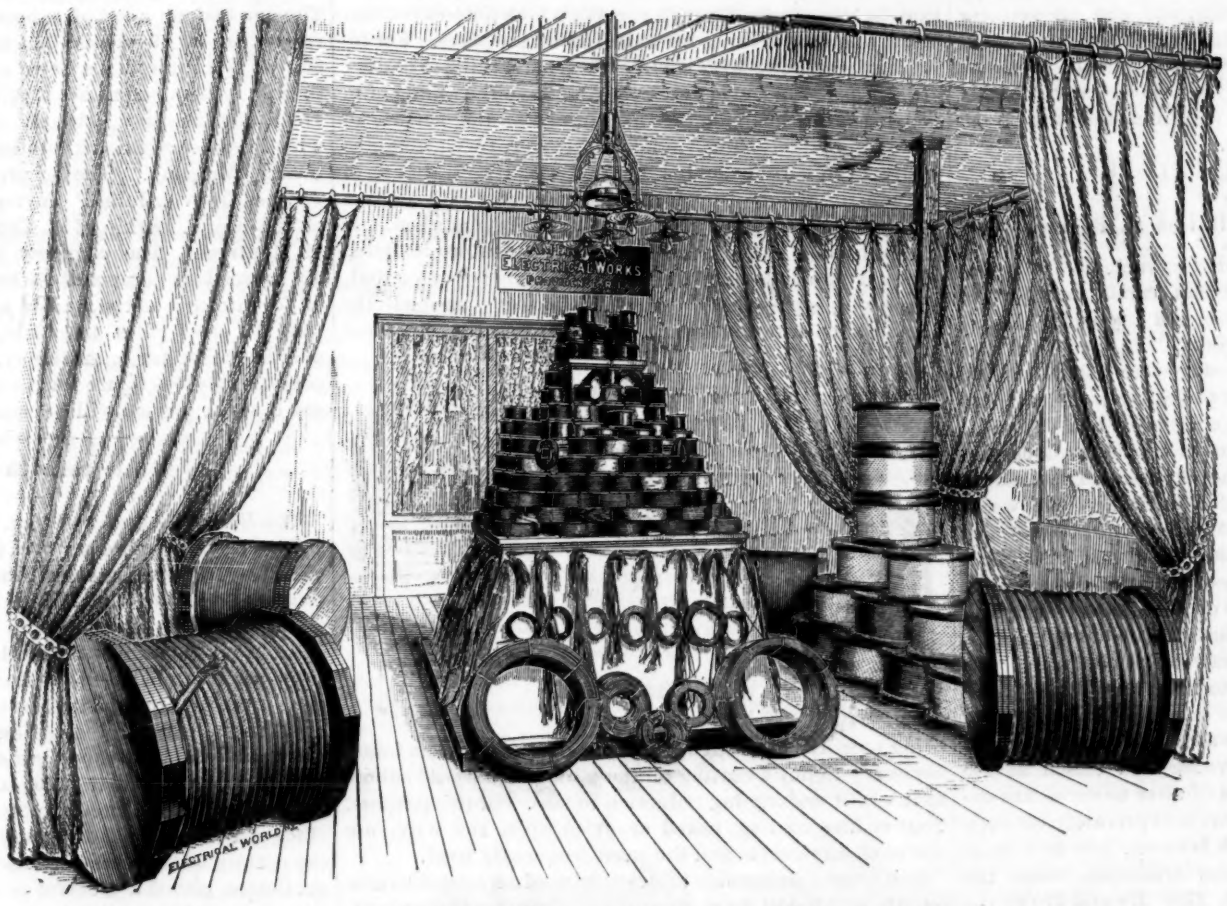
The fine illustration on this page represents the exhibit of wires and cables by the American Electrical Works, of Providence, R. I., at the recent Electrical Exhibition at Philadelphia. As will be seen from the cut, or remembered by all who visited Philadelphia, the wires and cables were artistically displayed and presented a pretty picture, in spite of the fact that such coils do not lend themselves readily to decorative effects.

Some descriptive notes on an exhibit so important will be generally welcome. The cables were, from their bulk, the most prominent, and may be taken first. The principal aerial cables manufactured by this company are the Lytle, Rubber Group, and Sabin. The Lytle cable is composed of copper conductors thoroughly insulated with rubber, and each conductor thus covered is surrounded with tin-foil. A number of these conductors are bunched together, generally 50 or 100, and completely surrounded with vulcanized sheet rubber. The cable is then passed through a loom, and a closely woven jacket of cotton or linen is woven upon it. The woven jacket is then thoroughly saturated with a water-proof paint. This style of covering is superior in many respects. The paint resists the entrance of moisture to a great extent, and water cannot penetrate further than the rubber covering under the woven jacket under any circumstances. Aside from its anti-induction properties, this cable recommends itself from its extreme lightness and the ease with which it may be strung on poles or over house-tops, and maintained in position. This cable, as well as the "Rubber Group," can be had for underground service, the only difference in the manufacture consisting in the substitution of a lead covering for the woven jacket.

The "Rubber Group" cable is in all respects the same as the Lytle, except that instead of each conductor being completely surrounded by tin-foil, the conductors are divided into groups of 6, 7 or 8, the centre conductor of each group being covered with tin-foil. For a perfect anti-induction cable, this arrangement is not theoretically as perfect as that by which each conductor is separately surrounded by tin-foil. It is claimed, however, that the presence of a certain amount of metal as an induction shield, properly distributed, will insure beneficial results. This reduction of the amount of tin-foil necessarily decreases the total weight per foot of the cable, which is a matter of importance. These cables have given satisfaction in all cases and some of them have been in use for three years in Boston, Providence and other cities.

The Sabin cable is composed of double-wound copper wires thoroughly soaked in a patent compound, and finished with braid, compound and rubber tape put on in double thickness, and the outside braid well saturated with paint. This is said by the concern to be the cheapest cable in the market, and has been used with success largely in San Francisco, where some eight or ten miles have been put in connection with the exchange.

Passing from the cable class, we come to office cables for connecting switch-boards together or with the wires from a cupola or tower. These are made in great variety, being composed of double-wound wires cabled together and thoroughly saturated with compound. An outside braided covering is then applied in colors to suit the surroundings.



THE EXHIBIT AT PHILADELPHIA OF THE AMERICAN ELECTRICAL WORKS.

The cords next demand attention. The patent spiral wire telephone cord has been foremost in the market for years. It is covered by numerous patents, and is held by many to be the perfection of a telephone cord. The conductor is coiled in a spiral. This form seems to be the best to resist the varied strains to which a telephone cord must be subjected. The construction prevents the occurrence of a sharp kink or bend to the conductor, as the spiral has a tendency to open and separate under such strain. For greater durability the spiral is made of iron wire. Each conductor is compactly braided with heavy cotton, and both are then neatly encased in a covering of worsted. The branches at each end are supplied with metallic tips, making a neat finish. The needle of the tips is securely soldered to the spiral, thus insuring a perfect connection. When desired, these cords are furnished with a rubber ball and appropriate clasps, by which it can be secured to a telephone. The rubber ball grasps the cord at a point removed from the tips, and in case of accidental dropping of the telephone the strain is thrown upon the rubber support and injury to the tips is prevented.

"Tinsel Telephone Cords" are also furnished, wherein the conductor is made of twisted tinsel. This gives a very flexible cord, preferred by some. If desired, fine copper wires can be incorporated in the tinsel cord, thus securing greater conductivity. Single Spiral Cordage is made in large quantities for use on switch-boards.

Various styles of electric cordage, aside from those specially mentioned, are furnished for all kinds of electrical work, differing with the kind of work and taste of the consumer.

A neat double cord is made for incandescent lighting. Fine wires are grouped together and covered with rubber. These are then braided and encased in a silk or worsted covering as one cord. In this form they occupy but little space, and can be readily attached to a fine chandelier without being unsightly, and, in fact, are ornamental.

The Patent Rubber-Covered Wire is covered longitudinally with the best quality of rubber in sheets, and the method of manufacture is such that the conductor occupies a central position in the insulating covering. It is finished generally with a braid of brown glazed cotton. This braided covering is employed to sustain the parts during the process of vulcanization. It is also of value as an extra protection to the rubber coating. This wire is used extensively for all kinds of work when extra protection is necessary. It does not crack from extremes of temperature, and its exterior braid protects it from abrasion. It has been largely used for electric lighting in cities, its insulating qualities recommending it for this class of work. For connecting fire-alarm and patrol boxes it has particular merit. Numerous letters from fire-alarm superintendents throughout the country, attesting its value, have been received by the manufacturers.

Another class is that of annunciator wire. This wire is double wound with cotton in opposite directions, and thoroughly saturated with patent compound. It is nicely finished and polished, and furnished on spools of about eight pounds. It is made in a variety of colors. The office wire is wound and braided or double braided with cotton. It is saturated with patent compound and compressed between revolving metallic arms, which remove the surplus compound and give the covering a fine finish. If desired it is still further finished with varnish, when it becomes the famed patent finished wire which has so long been manufactured at this establishment.

The Electric Light Line Wire is double braided, abestos painted and nicely finished. It is used extensively by all electric light companies for outside and inside work. The larger sizes are neatly wound on reels in long lengths, and the smaller sizes are furnished in coils. When flexibility is required, the conductor of this wire is composed of a number of smaller wires, sometimes as many as 50 neatly cabled together, to equal a solid conductor of the size desired.

In regard to fine wire, it may be stated that all of the fine wire used by this company is made by them. It is drawn from the best Lake Superior stock, and by an improved process, which produces long lengths and a greater degree of accuracy in uniformity of size than has heretofore been attained. The samples of very fine sizes of 36 and 37 B. & S. gauge, 4½ and 5 thousandths of an inch in diameter, in single lengths of 5 miles each, of unvarying diameter from end to end, were certainly fine specimens of what can be accomplished. The fine wire, after being covered with silk or cotton, is wound on spools ready for use. There is no rewinding, the wire being delivered on the shipping spool in the covering machine. This is a feature of importance, as the liability of stretching and breaking by rewinding is considerable and is in this case entirely avoided. It will be remembered that in our issue of Oct. 25 we touched on this subject in connection with the question of exactitude.

As we then remarked, the slotted gauge has given way to the micrometer gauge, and size is now specified by thousandths of an inch. A large portion of the fine wire drawn for electrical use has proven more or less out of size. Two samples of equal length cut from the same coil would give a different resistance when tested. When measured by the micrometer gauge, frequently a difference of from four to five thousandths of an inch would be found in the diameter at different places. Experiments, however, have been successfully conducted at the factory of the American Electrical Works with a view to the production of wire free from these defects, and the methods employed are the subject of pending letters patent.

The above is a general and by no means exhaustive description of the exhibit and the various admirable productions included in it. Other details can be obtained from the Works, such as price and the like, all of which, we believe, are dealt with in their catalogues.

Consolidating Electric Railway Interests.

Meetings have been held at the residence of E. N. Dickerson, Esq., on the evenings of Nov. 18 and 25 and Dec. 2, to consider the advisability of a consolidation of electric railway companies, with a view of placing all the resources of the art within the management of one company, having the capital required to equip and work railways. They have been attended by Messrs. Cyrus W. Field, Charles H. Coster, R. W. Hawksworth, Charles Hoeltzer, David Dudley Field, Rowland R. Hazard, E. N. Dickerson, Henry M. Field, E. N. Dickerson, Jr., H. M. Hawksworth, Stephen D. Field, Edward H. Johnson, F. K. Hain, representing various electro-motor interests.

Nothing has been accomplished by these conferences beyond the proposal of a form of agreement which has been informally submitted to the interested corporations, and the selection of a board of arbitration to be composed of Sir William Thomson, of Glasgow (corresponding member), and Messrs. Roberts, Rutter and Harris, Presidents of the Pennsylvania, Central and Northern Pacific roads respectively, and Dr. Cross, of the Massachusetts Institute of Technology.

It is proposed to institute a series of experiments upon the Second Avenue Elevated Railway in this city, as a basis for determining both the absolute value of any system, and the comparative value as developed, the board being the judges, without appeal; these experiments to be made at the joint expense of the Manhattan Railway Company and the competing corporations, the competing corporations first assigning an exclusive license for the life of their patents to the "consolidated company," in which they respectively take "stock" in full payment under the arbitration. The Manhattan road obtains special terms in consideration for its outlay and facilities.

This praiseworthy design to consolidate the railway interests has now been under consideration nearly two years. It is quite too soon to say, in the absence of any official determination by either interested company, what may or may not grow out of it; but it is reasonably certain that the plan as outlined cannot be carried out. The board is composed of one very eminent non-resident expert, three absolutely inexpert officials, and one pre-eminent expert absent foreigner. Whether the rest of the scheme is better than this remains to be developed, but the specimen is not reassuring to those who wish, as we most heartily wish, to see the electric railway in immediate use on all the city tram lines and railroads.

An adjourned meeting will be held Dec. 9.

How the Decision was Hailed in Boston.

It was natural that the decision favorable to the plaintiffs in the great Bell-Drawbaugh suit should create some excitement in Boston, the "hub" of telephone affairs. The Boston *Herald* of Dec. 2, says:

The merriest people in town to-day were holders of Bell telephone shares, who were apprised by a dispatch, received just past noon, that Judge Wallace had entered a decree in favor of the complainant in the famous suit against the People's company, that is, against Drawbaugh. Some holders were taken quite off their feet by the wording of the dispatch, but soon learned that the complainant was the Bell company, and regained their equipoise. Such a decision has all along been expected by the Bell people, but still the news was almost too good to be believed. By this decision it is considered that the Bell monopoly is practically established, as the Drawbaugh opposition was apparently the most formidable extant, and little fear is felt of a reversal of the decree on any appeal that may be taken. The effect on the stock was magical. It had sold at 220@215 throughout the morning and closed at 215 asked. The first quotation heard of after news of the decision arrived was 250 for one share sold privately between boards. Other sales of Bell stock between boards were at 240, 250 and 275, and at the regular afternoon board the quotations were 265, 260, 266, 270, 272½, 275 and 270 at the first call. At the second call, sales were made at 265@265½, and the day closed with 265 bid, 266 asked. There were 829 shares dealt in during the day, 115 representing the forenoon business. It is street opinion that top figures have been touched for the time, but that 300 will be passed later. There is already talk of an increase of dividends from 3 per cent., and the company can make it and still lay by considerable surplus. Whether it will tempt adverse legislation by such proof of large earning powers is another question.

New England telephone was firm this morning at 36½@36¾. The output of telephones by this company in October shows a net loss of 54, all except five of the instruments returned being those used at the summer resorts. The number in actual use Nov. 1 was 17,737. The New England Company, from its intimate relations to the Bell company, is looked upon as an especial beneficiary by the decision above mentioned. The stock jumped from 37 asked, at the close of the morning board, to 43 between boards, reacted later to 41, and rallied to 42. Erie rose from 20½ to 21½, and fell back to 20½. Mexican was 1½ bid, 1 15-16 asked, and Tropical 1½ asked. Officers of the latter company are pleased at the triumph of the Bell in the suit in question and consider themselves absolutely benefitted thereby.

Western Union rose from 60¼ to 62½. The directors will declare a dividend of 1½ per cent. Wednesday. The number of shareholders has increased 348 in 11 weeks. Western Union is another beneficiary under the telephone decision, having, beside its 20 per cent. interest in the income of the American Bell company, miscellaneous telephone stocks of the nominal value of $3,221,285.71 as per its last report.

Overhead Telegraph Wire.

BY WM. MAVER, JR.—PART II.

The term "hard drawn" is derived as follows: Iron or copper intended for telegraph purposes is, while red hot, put through rollers, which reduce the bars to a certain thickness. The rods or wire thus formed are then allowed to cool, when they are pulled through a die of the proper size by powerful machinery. Having run through this die, they may then be put through another die of smaller size, which reduces the diameter of the wire still more. Thus, in Fig. 2, we will suppose that the wire on the drum or reel *D*, on the floor, has already been passed through one or more dies, which have reduced it to a diameter of, say, 109 thousandths of an inch, or about equal to a No. 12 wire, Birmingham wire gauge.

It is, let us say, desired to reduce it to 83 thousandths of an inch diameter, or equal to No. 14 gauge. For this purpose it is placed in the die *I* on a bench, which is a cone-shaped hole bored in a solid plate of steel, the hole at its smallest end having in this case a diameter of 83 thousandths of an inch. An inch or two of the end of the wire having previously been tapered so that it will pass readily through the die, a pair of nippers connected by a chain to the drum *D* is caused to revolve, and in revolving it draws the wire through the die. It will be understood that the drum *D* unwinds as fast as needful. Should it be required to reduce the wire still more, the drum *D'*, standing on a slightly higher bench, is lifted from off its support and placed in the position now held by *D*, or the wire may be lifted from *D'* to *D* and again passed through another die of the desired size.

It is necessary that wire should undergo a special preparation for its passage through the die, which process consists of putting on a coating for anti-friction purposes. For instance, in starting with a wire rod, the first thing to be done after it has been rolled to the desired size in the rolling mill, is to clean off the oxide that has formed on the surface of the wire, by "pickling" in acid. If it were then attempted to draw the wire through a die the two surfaces, that is, of the wire rod and the die would come in contact with nothing between them and the wire would be badly scratched, and the die quickly worn. Some lubricant is therefore rendered necessary, and oil alone is not sufficient, for the reason that, as the wire is passed through a hole smaller than itself, the oil would be crowded back, thus preventing the wire from

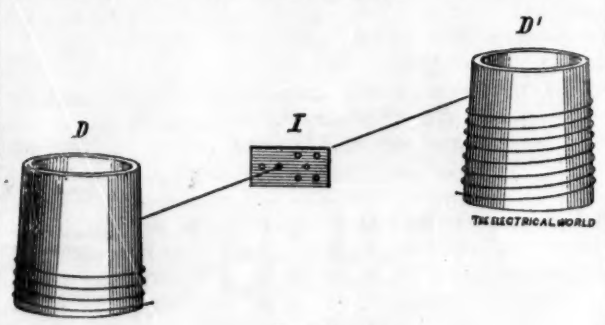


Fig. 2.

being properly lubricated. It has consequently been found necessary to put a coating on the wire which would adhere to it whilst undergoing reduction in size. For this purpose, flour or lime coating, baked or dried upon the wire, are the most serviceable and the most frequently used.

It is almost impossible to draw wire of any considerable length which will have an uniform diameter throughout, but the discrepancy does not and should not vary more than the 1 thousandth of an inch in extreme cases. A picture giving a good idea of the process will be found in The Electrical World of Nov. 15, on page 190, in connection with the description of wire drawing in France.

The difficulty in drawing wire of exactly uniform size throughout its entire length is due both to the wearing of the die and filling up of the die, that is, some kinds of metal, in certain conditions, "cut out" the die, or make the hole larger, while other kinds will "stop up" the die, thus making the wire larger or smaller as the case may be.

It is, I presume, understood that in this drawing process there is no waste of the metal of the wire, such, for instance, as would be caused by filing. The wire is actually drawn out thinner, so that there is, while the wire is running through the die, a ridge or wave of metal pushed back at the large end of the die—therefore when a certain wire has been passed through a die it is much longer than previously, but its weight is the same.

It is not quite plain why the copper wire now being manufactured for telegraph lines should be so prominently put forward as "hard drawn" copper wire, as the only kind of iron wire used for telegraph wire is hard drawn. It has been stated that one reason for giving copper wire this distinctive title is that an impression had prevailed for years that copper would not stand hard drawing; that in the process of so drawing it continually broke, the cause of which would appear to have been that the copper thus experimented upon was an impure metal. There is some foundation for this statement in the fact that within the past 15 or 20 years the specific conductivity of commercial copper has increased from about 85 to 98 and 99—100 being the standard for pure copper wire.

Be that as it may, however, there is no question as to the present ability of all the principal wire-manufacturing companies to produce a hard-drawn copper wire which will stand a breaking strain of from three to three and a half times its own weight per mile. In attaining this high degree of tensile strength each company claims to do so by a process known only to itself, which process they claim to have arrived at after a great amount of experimenting; and consequently guard the secret very tenderly.

It has been conjectured by outsiders that a considerable portion of the secret of this process consists of the manner in which the metal is permitted to cool, it being known that the greatest degree of ductility, and, consequently, softness, is attained by suddenly cooling this metal by immersion in water. A gradual and systematic process of cooling while passing through the rollers would probably increase the hardness of the same metal.

Telephone Interests in Canada.

The Toronto *World* has interviewed a representative of the Canadian Telephone Manufacturing Company, with which the Bell company is engaged in a lawsuit, who said that "they were now going ahead for all they were worth. Even if the decision of Hon. Mr. Pope should go against them, of which they had no fear, they still would go ahead and fight the Bell company. They had patents of their own, and their instruments, he claimed, were better. They were now operating exchanges in opposition to the Bell company at Port Arthur and Owen Sound. The Telephone Manufacturing Company was intended to be a parent company, a manufacturing company which would supply the instruments and plant to local companies in all the towns. For instance, the local company at St. Thomas had got a list of subscribers which included the entire list of 59 of the Bell company and 14 others. At Ottawa 200 names have been got for the local company there. Letters patent are now being asked for the Toronto Telephone Company, with a paid up capital of $100,000, which is to work this city under the Telephone Manufacturing Company. The incorporators are John Turner, Thomas Ogilvie, John P. Taylor, F. D. Byrnick, R. Dinnis of Toronto, P. Larkin of St. Catharines, and F. Stancliffe of Montreal. The company have already secured about 500 subscribers composed of the influential business men of Toronto, and as the council has already granted permission to erect poles and string wires, active operations may be looked for immediately. They purpose asking a considerably less figure for their instruments, while they say that the service will be equal to the Bell."

Music through the Wires.

The *Boston Traveller* of Nov. 24 says:

On Saturday morning the New England Telephone Company, by permission of Manager Lonsdale of the Bijou, placed two common Blake telephone transmitters on the side of that theatre, one on either side, and adjusted them in positions most favorable to catch the voice of any person that might be on the stage. To these transmitters were attached strong batteries and wires, the latter running to the office of the New England Telephone Company at No. 50 Pearl street, where were placed in this circuit 20 pairs of receiving telephones.

In the evening a number of gentlemen gathered at the office of the telephone company and awaited the rise of the curtain at the theatre. About 8 o'clock one of the gentlemen placed a receiver to his ear and informed his companions that he plainly heard the strains of the orchestra. All took receivers and experienced the novel pleasure of applauding the efforts of musicians in a different building many blocks away.

The singing that followed was also plainly heard and listened to attentively. "A captain bold as brass," so delighted the telephone gentlemen that they applauded with the theatre audience. Other experiments will follow and slight improvements in the system will be made.

Troubled Telephonists.—The New York and New Jersey Telephone Co., last week, proceeded with pole-planting on the east side park lands of Brooklyn, but the city authorities called a halt. The N. Y. & N. J. T. Co. obtained permission some time since to lay wires under several important streets of Brooklyn, but hitherto the privilege has not been acted upon by the company. It now begins the work.

More Telephone Litigation.—As the curtain falls upon one scene of telephone litigation, it rises again to reveal another. The United States Telephone Manufacturing Co., and its licensees, representing the McDonough interests, have begun suits against the American Bell Telephone Company, and its licensees, the Metropolitan T. & T. Co., in New York, the Michigan Telephone Co., in Detroit, and the Bell Telephone Company, of Philadelphia. It is said that other suits will soon be begun. They are all, we understand, based on the claim of Mr. McDonough to priority in the invention of the receiver and transfer the question from the Patent Office to the courts.

Dynamo-Electric Machinery.*

BY PROF. GEORGE FORBES, M.A., F.R.S.E.

(*Continued from page* 218.)

I will show you next another experiment to illustrate the analogy between the electric current and magnetism, which follows directly from Oersted's experiments. Here I have a mass of iron or sets of bars going directly downward, with iron at their base and coils of copper wire surrounding them through which I can pass an electric current. As soon as I pass such a current through the wire this becomes a powerful magnet capable of attracting iron objects placed in its neighborhood. It will hold a bar of iron like this with enormous intensity. So, if I tumble upon the poles a quantity of nails, the magnetic attraction is so great as to give the nails the appearance of cohesion which enables them to stand upright in a bridge; but as soon as I take away the current they fall down, which shows that the magnetism has left the magnet as soon as the current ceases to flow. (See Fig. 4.) In this experiment the north polarity is urged through the iron in the direction indicated by Oersted's experiment.

Having shown you how a magnet can be produced, I will show you the experiment which I described just now. Here I have a coil of wire analogous to the coil which Mr. Knapp was just now holding in his hand, and here I have a bar of iron, and I have said that if I have a north pole under here it will be sucked up if the current is going in the right direction. Now the coil will magnetize this bar. As soon as I have magnetized the bar it has a north pole at the top, which is powerfully sucked in. The intensity of the magnetic effect of this current of electricity is so great that I have considerable difficulty in dealing with this mass of iron which I am holding in my hand.

Now, in this experiment, I wish to point out to you the key that exists to the whole of the researches of Faraday, which were made some years afterward. When I have this magnetic needle, which is deflected by the current, or this bar which is sucked into the coil, it is evident to every person of sense here that work is being done. That is to say, that when the needle is moved away from the position which it naturally occupies, work is being done. Where does this work come from? It comes from the interaction of the compass needle and the electric current. It is, therefore, safe to say that when a compass needle is moved in the neighborhood of the electric current it is doing work, and in order to do work it must take away a part of the current from that current which is acting. Now, in order to take away from the current it must have started a feeble opposing current in an opposite direction. And here is the point that I wish you to grasp, that in the movement of the compass needle from one side or the other, an opposing electromotive force has been created, that is, a force tending to set up a current in the wire in the opposite direction. This I believe was the manner in which Faraday argued the matter out in his mind, and that is how he was able to originate the experiments which he made to produce the opposite result, that is, to create a current in the wire.

Hitherto, Oersted had shown that a current could produce motion in a magnet; Faraday conceived the idea that by the motion of the magnet we could produce a current in the wire. This experiment I shall now be able to show you. By moving a magnet pole into a coil, you will be able to see a movement of the pointer which I have here, and which indicates the strength of currents which are made to flow through wires which are connected with it. This instrument which I have here is a galvanometer, an instrument whose object is to measure the strength of electric currents. You see the index traveling over the scale at the present moment; it now points almost to the middle of the scale. If, then, I take an ordinary coil of wire and reverse the experiment which I was talking of a short time ago, that is to say, pass the pole of the magnet into the coil of wire, we shall find that the electromotive force is started in the coil of wire, and if the circuit of the wire forming the coil be completed through the galvanometer, we shall find that a current is created which will show itself by the deflection of the galvanometer. (See Fig. 5.) Now, in order that this be made distinct, I shall ask Mr. Knapp suddenly to insert the north pole of the magnet into the coil of wire. The movement of the galvanometer will be very slight, but you will be able to see it. I will now ask him to withdraw the pole and the movement will be in the opposite direction. In this manner I get up a sort of swing in the galvanometer which is more visible to you, and shows that I can move the galvanometer needle from one side to the other when I put in the north pole of the compass or draw it out. The motion, you see, is very slight, but I am perfectly able to control it; it moves always to the right when I put the pole in, and always to the left when I take the pole out. This movement of the index proves that Faraday's notion was right.

I am anxious now to show you this experiment in another way, for it shows a further development of our notion, which will enable you to understand the application of Faraday's principle to the construction of the dynamo machine, which we will be investigating in a few minutes.

Here I have a coil of wire connected with the galvanometer. In the coil is a bar of iron. I show you that when I magnetize the bar of iron which goes through it, there will be a deflection of the galvanometer, and when I reverse the magnetism there will be a deflection in the opposite direction; so that when I have a piece of iron inclosed in the coil of wire all I have to do is to magnetize it by the influence of these neighboring poles. Mr. Knapp will now magnetize the pole by touching the end with a magnet; as soon as it is magnetized there is a movement to the right. Reverse now—there is a movement to the left. This is

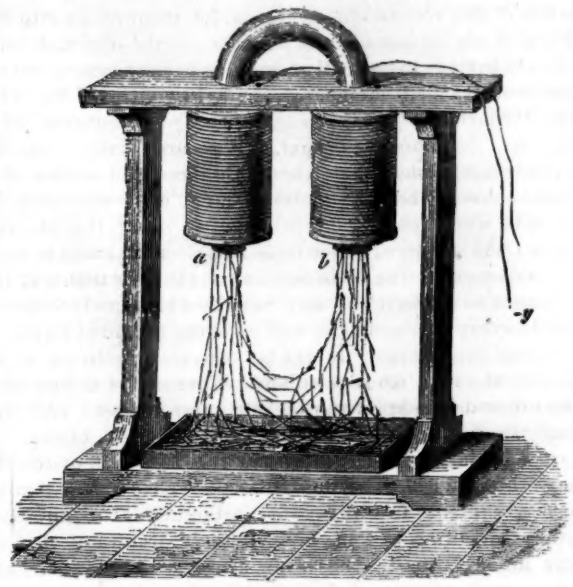


FIG. 4.

merely an experiment which assists our comprehension of the construction of the machine, or shows that magnetizing the iron core produces the same effect as the introduction of the magnetic pole into the system.

(TO BE CONTINUED.)

* A lecture delivered by Prof. George Forbes, M.A., F.R.S.E., of England, at the International Electrical Exhibition, Philadelphia, under the auspices of the Franklin Institute, on Sept. 16th.

Imperfections and Wants of Submarine Cables.

In submarine telegraph cables, their weight, a recent European writer points out, is an important consideration as regards their original cost and also in submerging them and in taking them up for repair. When raising a cable, the grappling-irons holding it have not only to resist the vertical component of its weight, but the added effects resulting from friction against the water, which at great depths would expose it to greater strain than it was able to bear; and to bring it safely to the surface, two or three ships are often used, which take up the cable with their grappling-irons, at distances which enable it to bear its own weight. Or, in very simple cases, an auxiliary buoy is used to sustain one lift while the ship grapplings raise another portion at an extended interval.

How to decrease the weight of cables is a matter of study and importance. One reason for the great weight is that the copper core takes no part in the strain which the cable has to resist. Copper cannot bear a breaking strain greater than 28 kilos per square millimetre; and, besides, were the core obliged to bear any portion of the strain upon the entire cable, it would be drawn out beyond its limit of elasticity, and remaining permanently elongated, while the encasing would return to its original length, it would become crooked and curved, force its way through its gutta-percha covering, and so decentralize the wire and open out a fault in the cable.

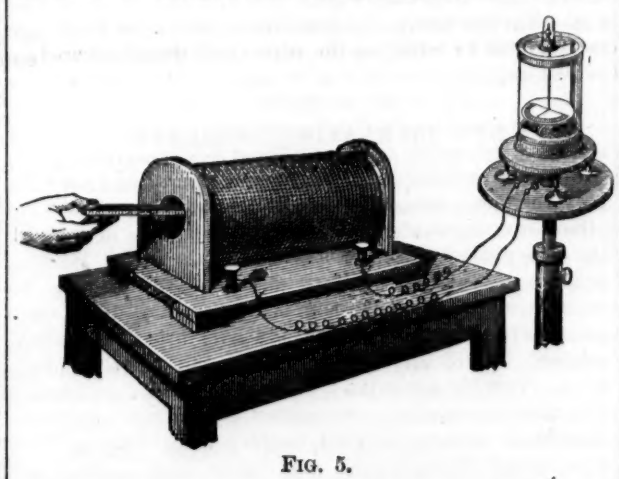


FIG. 5.

But an alloy (silicium bronze) can be drawn out into wires having all the conductivity of copper, and the mechanical resistance of best iron. These wires are now made with a conductivity of from 97 to 99 per cent. of the standard, which is at 0° C., and with the diameter of a millimetre, having a resistance of 20.57 ohms per kilometre, and able to stand, without breaking, a strain up to 45 or 48 kilos. per square millimetre, besides which their increase in length at the moment of rupture does not exceed one or one and a half per cent.—a most valuable property. The use of this alloy would render it possible to relieve the coating of the cables from part of the strain now imposed upon it, and to lessen considerably their dimensions and weight.

The deep-sea section of the so-called "Pouyer-Quertier" cable, constructed and laid by Siemens Bros., of London, in 1879, from Paris to New York, in respective weight of each of its component elements, per nautalic mile, shows: Copper core, 220 kilos.; gutta-percha, 180 kilos.; hemp, or an equivalent, 80 kilos.; 18 wires of galvanized iron, of 2 millimetres in diameter, 800 kilos.; external hemp and composition, 400 kilos.; total, 1,740 kilos. Total diameter, 30 millimetres. Total mechanical strength, 3,000 kilos., the wires of the covering being supposed to be of iron. Weight under water, 450 kilos. For a distance of six or seven miles it can support its own weight without breaking.

At about an equal distance from America and Europe, the Atlantic Ocean shows, from north to south, in 50° north latitude a sort of longitudinal ridge, in which the depths vary from 300 to 400 metres, and in this region have been laid the principal cables which connect the United States with France and England. On both coasts there are depressions in which the bottom is at the depth of from 4,000 to 6,000 metres. The one on the east extends from the south point of Ireland to the latitude of the Cape of Good Hope, and its left-hand boundary follows the general outline of the west coasts of Europe and Africa. The two others, bordering on the United States and the Antilles and South America, form respectively the northwestern and southwestern basins.

That depths exceeding 6,000 metres exist in these depressions, soundings have proven, the principal of which are found to the west of the Canaries, the south of Newfoundland, between Porto Rico and the Bermudas, and to the right of the isle of Marten-Vaz. The great depth of the Pacific, differently distributed between 40° and 50° north latitude, between Japan and California, is the Tuscarora depression with its depths of from 6,000 to 8,000 metres, and the deepest point known, 8,513 metres, lies parallel to Japan and the Kuriles.

It is evident that any new great submarine cable having to extend into a zone other than that which has received the existing Atlantic cables, must traverse depressions in which the bottom reaches a maximum depth of 4,000 metres. To raise a damaged cable under such conditions would be very problematical, and in case of a cable from San Francisco to Japan it would be an impossibility.

Hence, it would seem, in view of considerations and deductions from these facts, that the geographical limits of submarine telegraphy had been reached, and must be confined to certain zones of the Atlantic, to inland seas, and to lines along the coasts. But the continually increasing demands for rapid communications between nations will compel investigation and supply light cables, easy to lay, possible to repair, and of strength sufficient to traverse the greatest depths of the ocean for long distances.

According to the writer we quote from, a cable made by Mr. J. Richards foots up: Core of silicium bronze, 220 kilos.; gutta-percha, 180 kilos.; layer of hemp, 80 kilos. The sheathing is formed of 28 wires of galvanized iron of 1.25 millimetres in diameter, each covered with hemp, and all twisted into a rope around the dielectric: the wires, 500 kilos.; the hemp covering them, 250 kilos.; weight of cable, 1,230 kilos. in the air, and 320 kilos. in the water; diameter, 25 centimetres; resistance to fracture, 2,800 kilos., of which the core supports one-half. This cable can sustain from eight to nine nautical miles of its length and can be raised from the greatest depths.

For equal conductivity and an approximately equal mechanical strength, the new cable is in bulk and weight about one-third less than the Pouyer-Quertier cable; it would cost per mile $165 less, and requiring less ship room and engine power and be cheaper in every way. The reduced armature will enable it to resist friction and attacks of deep sea habitants, but for shore ends the usual type must be employed.

All inventions undergo modifications in detail, and in the daily progress of applied science and from more complete study and experience there is little doubt but that many of the difficulties will be surmounted and the "impossible" once more proven to be of comparatively easy performance.

Telegraphing the President's Message.

The message of President Arthur to Congress was given to the telegraph companies a few hours in advance of its delivery to the Senate and House, on Monday, Dec. 1, with instructions to transmit and hold until permission was given for its publication by the press. The message contained 9,577 words. It was received at the office of the Western Union Telegraph Company, in this city, from Washington, upon ten wires, two operators taking each twelve manifold copies from each wire. The time occupied in its transmission was exactly forty-nine minutes, being an average speed of 19.5 words per minute. It was sent westward over 6 wires at the average speed of 17.5 words per minute; eastward over 4 wires, speed 19.9 words per minute, and through New York State upon 4 wires at a speed of 19.7 words per minute. It will be noticed that the speed attained was not very high, but this was not expected, as perfect accuracy and reliable work were enjoined upon all.

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THE ELECTRICAL WORLD,
NEW YORK.

NEW YORK, DEC. 6, 1884.

THE DRAWBAUGH CASE.

We give on the next five pages, in full, the decision of Judge Wallace, of the United States Circuit Court for the Southern District of New York, in the suit of the American Bell Telephone Company against the People's Telephone Company. The decision is one of the most important ever rendered in any case in this country, and brings to a close litigation that has extended over four years. The interests involved cannot at the present time be worth less than $100,000,000, while it is impossible to calculate any limits to the growth of the telephone business during the full lifetime of the Bell patents. The case appears to have been fought on both sides in a determined manner without regard to expense.

We have no doubt that, to a great many people, the decision filed by Judge Wallace comes as a surprise of the not most welcome character, but we apprehend that by the majority of electricians familiar with the evidence and the development of the telephonic art, it will be accepted as inevitable and just. Speaking of the Drawbaugh claims ourselves last April in these columns, we said: "What is exceedingly strange is the fact that these forms of apparatus all bear a more or less striking resemblance to the practical forms of telephonic apparatus that have been used by Bell and others and introduced in common use. It would appear, in fact, from the study of these instruments, that not only had Mr. Drawbaugh invented the art of telephony before 1876, but that he had exhausted every one of the resources of invention which have been drawn from by subsequent inventors in their aim to improve the art. For ourselves, we admit that these wonderful coincidences have taken our credulity by surprise and left us rather skeptical in presence of this vast array of testimony." In other words, we found it more satisfactory to believe that the doctrine of evolution applied with strict fitness to the art of telephony. This is precisely the purport of the decision of Judge Wallace. He says in so many words almost that telephony is a scientific growth or development, but that while Drawbaugh "seems to have discovered nothing accidentally" to start with, "yet from the beginning to the end of his narrative there is nothing to indicate the conceptive origin or the mental growth of the alleged invention." Moreover, "it is almost incredible that the subtle intellectual discoveries which were a closed book to the ablest electrician could have been reached by a smatterer in science or by any series of experiments." Judge Wallace dwells on this idea, and adds: "An inventor can hardly forget the process of thought by which a great intellectual conception germinates and matures into the consummate achievement; but Drawbaugh's memory is a blank." Not satisfied with showing the absence of continuous mental evolution, Judge Wallace devotes a large portion of his decision to an exposure of the fragmentary and miscellaneous nature of the instruments made by Drawbaugh and the results alleged to have been obtained from them. The Drawbaugh telephones are not, says the Judge, any proof of the perfect evolution claimed. "The proofs on both sides lead to general conclusions that Drawbaugh was not an original inventor of the speaking telephone, but had been an experimenter without obtaining practical results until the introduction of the (Bell) instrument into Harrisburg."

Having printed the decision in full, we are relieved to a great extent from the difficult task of summarizing a paper so able and conclusive. Our readers who do not dislike intellectual exercise will find profit in following the argument and exposition step by step, for although Judge Wallace dismisses as trivial much of the voluminous evidence, he compresses into the decision an immense amount of carefuly digested data. We are invited to see Bell at work in patient investigations and with skilled assistance, and to contrast him with the "charlatan" Drawbaugh, whose inventions were in no instance original. We are taken among Drawbaugh's friends and acquaintances and shown that while some of the most material facts were misstated by them or were associated with wrong dates, the absence from their stories of other facts and circumstances is even more damning. The consideration and the discussion of the evidence as far as it had any value are extremely interesting to every electrician as well as to the public at large.

"Exit Drawbaugh" might be said, for admitting as all do that the man made telephonic experiments it has been shown, and is held by one of our most upright and distinguished judges, that the Drawbraugh claims to early attainment of perfection in the art of telephony are without foundation. "That Drawbaugh was a skillful and ingenious mechanic is undoubtedly true. Invention was his hobby and vocation, but that he was an inventor in the large sense is disproved by the nature and results of his work. Every patent that he obtained was for some improvement on existing devices which involved mechanical skill rather than any high degree of inventive faculty." The phrase "in the large sense" is philosophic, and hardly to be looked for in a dry legal decision, any more than the psychological science brought to bear on the workings of Drawbaugh's mind, but it seems to us to be very appropriate, as true in this case in theory and in fact. Drawbaugh is one of those men known to us all—men who no sooner hear of an invention than they declare that they had it long years ago and can offer evidence to support their assertions. But a wide gulf yawns between experiment and achievement, between crude principles imperfectly comprehended and the perfect art following the ingenious and skillful adaptation of means to ends.

Some of the results of the decision have already been experienced. It is said that the case will be appealed to the Supreme Court, but an appeal of that kind in such a case involves only remote contingencies. The stock of the parent Bell Company and its offspring has bounded upward, and that of the former will probably stay above 250. Less than six months ago it went below 150! One effect of the decision will be the discouragement of further telephone litigation, although it is noteworthy that the McDonough claims are to be actively pushed in the teeth of this greatest victory of the Bell patents. Another effect is that the telephone business will improve. The outlook has been much brighter throughout the week, and we hear from telephonists generally that, now the uncertainty has been removed, affairs are on the mend. The subscribers may still feel the pinch of dull times, but the telephone companies, secure in their position, will work with greater vigor, and thus secure larger patronage.

A NEW JOURNALISTIC ENTERPRISE.

In the advertising columns of this issue will be found the prospectus of a new journal to which we wish to draw the attention of our readers. *Industrial America* will be under the same general management as THE ELECTRICAL WORLD, but of course will have its own special editorial staff. To state its objects briefly, it is to be a popular record of progress in the mechanic and industrial arts and applied science. It will aim to be in its comprehensive sphere what THE ELECTRICAL WORLD is in the electrical field—a worthy representative journal. Its character and contents will be distinct from those of THE ELECTRICAL WORLD. At the same time, it will not ignore electrical matters. It will give the same attention to progress in electrical science that it will to progress in other sciences or arts.

It is believed that *Industrial America* will be found of especial interest and value to electricians and those connected with electric lighting, telephony and telegraphy. Busy men who have little time to more than keep up with the new inventions and discoveries in their own department of science, will find *Industrial America* a welcome visitor, for it will keep them informed, briefly and intelligently, of whatever of importance may be transpiring in other fields of industry and research.

Like THE ELECTRICAL WORLD, the matter in the new paper will be original and written from the American standpoint in plain and popular language. Its pages will be embellished with copious illustrations, and other features embodied to make it an interesting and pleasing review of the progress of the times. It will maintain independence of all considerations other than the approval of its readers.

We shall appreciate every expression of good will on the part of our friends toward *Industrial America*, and shall earnestly labor to make the paper merit their confidence and favor.

THE COINAGE OF NEW WORDS,

The discussion in our columns regarding the legality and propriety of "Motoneer" has been interesting. To-day we publish two further contributions on the subject. In one, Mr. Lockwood makes the point that to do as Ampère suggests and apply the word "Motorman" to the functionary who runs the electric motor would be usurpation on the part of electricians, as the word belongs to all the mechanic and engineering arts in common. There is sound sense in this view of the matter, and we would call attention to the fact that a "Motor" Exhibition is now being held at Vienna. That exhibition includes all kinds of machines operated by means of water, gas, air, steam, electricity and sheer brute strength; and it would seem rather odd and unfair to pick out the word "motorman" for the one electrical class, and leave all the men employed on the other motors without any distinctive designation. But the same remark will apply, of course, to "motoneer," in regard to which Mr. Mansfield says today that criticism of his proffered addition to the vocabulary of electrical science will be welcome, if it be constructive rather than destructive. We are glad to note, too, that the opportunities for punning afforded by the discussion are nearly all exhausted. There remain now for torture only the substantive "mote" and the obsolete verb "mote." We would therefore recommend that the subject be hereafter treated more *au serieux*, as it is certainly no laughing matter.

THE SURPLUS OF THE PATENT OFFICE.

The condition of the Patent Office is not the least agitated question of the hour, and we trust that ere long steps will be taken to remedy the evils described by us last week. Already we note discussions as to the best method of disposing of the surplus revenues, now between two and three million dollars, but we would ourselves like to feel more confident that the money will be used for the benefit of those from whom it first came. Some persons advocate a reduction of the fees, but although that would keep future surplusage down to a minimum it does not dispose of the hard cash in hand. Others would build a big new Patent Office, in which the employés would have elbow room and where the records would be easily accessible. The idea, like the other, is a good one. We would be glad to see the salaries of competent men in the office increased, so that they may be tempted to stay in when once they have familiarized themselves with the routine of the work, and can give valuable aid to the inventor. Probably the surplus can be made best use of in a plan looking to two main objects—the provision of a patent office building and the increase of the force as well as of certain rates of salary. These ends secured, inventors will not raise much clamor for a reduction of fees.

A PRAISEWORTHY MOVEMENT.

We record elsewhere in our columns the progress of a movement among telegraphers for the organization of a building society. The scheme has our entire approval, and if started upon a sound, prudential basis will have our hearty support. As we understand, it is not proposed to restrict the membership to telegraphers, but to include electricians in all occupations, and even to seek wider affiliations and support. Building societies when conducted with wisdom and economy are great boons to men of medium incomes, with family responsibilities, and we know of many instances in which they have been productive of the greatest good. There is no reason why the society should not begin its operations at an early date with a large roll of members and with a great many shares taken up. We cannot impress too strongly on electricians and members of the telegraphic fraternity in this city of extravagantly high rents the necessity of carrying forward this scheme to a successful issue.

The Boston Electrical Exhibition.

With respect to the further postponement until Dec. 8 of the Exhibition, we publish the following request, in response to which the change of date was made:

To the Management of the Electrical Exhibition, Boston.

GENTLEMEN: The undersigned, intending exhibitors at your Electrical Exhibition, desire to call your attention to the fact that, from a variety of unavoidable delays in making their installations, they cannot be fully ready and prepared to display their various systems at the time set for opening, viz., Wednesday, Dec. 3, and therefore respectfully ask that said opening be further postponed until at least Monday, Dec. 8, at which time they believe they can have their exhibits in a condition that will be satisfactory to themselves and pleasing to visitors to the fair.

American Bell Telephone Co.; Western Electric Co.; Thos A. Edison; the New England Weston Electric Light Co.; Edison Co. for Isolated Lighting; the Consolidated Electric Light Co.; Blodgett Bros. & Co.; Benson Bidwell, for the Bidwell Railway Co.; White House Mills.

Judge Wallace's Decision.

We give below in full the text of Judge Wallace's decision in the suit of the American Bell Telephone Co. against the People's Telephone Co.

UNITED STATES CIRCUIT COURT,

SOUTHERN DISTRICT OF NEW YORK.

American Bell Telephone Company against The People's Telephone Company et al.

WALLACE, J.:

The suit is brought to enjoin the defendants from using, and furnishing to others for use, the several inventions described in two patents granted to Alexander Graham Bell, of Salem, Massachusetts, being No. 174,465, bearing date March 7, 1876, for "Improvements in Telegraphy," and No. 186,787, bearing date January 30, 1877, for "Improvements in Electric Telephony." The issues made by the pleadings are practically resolved into the single question, to which the proofs and arguments of counsel are mainly addressed, whether the patentee Bell, or Daniel Drawbaugh, of Milltown, in Cumberland County, Pennsylvania, was the first inventor of the electric speaking telephone.

Concededly Bell was an original inventor of the telephone, the principles of which, with the essential means for its application, are described in his first patent, and of the improved apparatus described in his second patent. The fifth claim of the first patent is for "the method and apparatus for transmitting vocal or other sounds telegraphically by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds substantially as set forth." This patent has been judicially construed in two cases in the Massachusetts Circuit; and in both cases it was substantially held that Bell was the discoverer of the new art of transmitting speech by electricity, and the claim should receive the broadest interpretation to secure to the inventor not the abstract right of sending sounds by telegraph without regard to means but all means and processes described which are essential to the application of the principle. American Bell Telephone Co. *vs.* Spencer, 8 Fed. Rep., 509. Same *vs.* Dolbear, 5 Fed. Rep., 448.

In view of the conclusion reached upon the merits of the issue it is not material whether Bell's inceptive invention did or did not antedate the time of filing his application for the first patent. That application was filed Feb. 14, 1876. It describes apparatus which was an articulating telephone whether Bell knew it or not. Mr. Cross, an expert, caused apparatus to be made in conformity to the descriptions and to drawings as shown in Fig. 7 of the patent, which proved itself to be an operative, practical telphone. Probably the date of his inceptive invention might be carried back to July, 1875, but irrespective of the time of the invention the justice of his claim to be an original inventor of the t lephone must remain unchallenged. It was through him also that the telephone was made known to the scientific public, and thence introduced into commercial use.

The defendants contend that long before Bell had perfected his invention, and long before its mental conception by him, Drawbaugh had not only made the same invention, but had perfected improvements in organization and detail which Bell has never reached, and which were only reached years afterward by the work of many other inventors in the same field of improvement. Their theory of the facts is stated with substantial accuracy in the answer to the bill of complaint. The answer, among other things, avers that Drawbaugh was and is the original and first inventor and discoverer of the art of communicating articulate speech between distant places by voltaic and magneto electricity, and of the construction and operation of machines and instruments for carrying such art into practice; that the said electric speaking telephones so constructed and successfully and practically used by him contained all the material and substantial parts and inventions patented in the two patents granted to Bell, and also contained other important and valuable inventions in electric and magneto telegraphy; that some of the original machines and instruments invented, made, used and exhibited to many others long prior to the alleged inventions of Bell are still in existence and capable of successful practical operation and use, and are identified by a large number of persons who personally tested and used, and know of their practical operation and use in the years 1870, 1871, 1872, 1873, 1874 and both subsequently and prior thereto; that said Drawbaugh, for more than ten years prior to 1880, was miserably poor, in debt, with a large and helpless family dependent upon his daily labor for support, and was from such cause alone utterly unable to patent his said invention or caveat it, or manufacture and introduce it upon the market; and that said Drawbaugh never abandoned his invention nor acknowledged the claims of any other person thereto, but always persisted in his claim to it, and intended to patent it as soon as he could obtain the necessary pecuniary means therefor.

Drawbaugh, in his testimony, adopts the statements of the answer as true. He also testifies that he commenced his experiments with the electric telephone as early as 1866; that prior to or as early as in 1867 he had made apparatus (in which he employed a teacup as the body of the instrument), through which speech could be transmitted feebly and incoherently; and that as early as the birth of his son Charles he had so progressed that his wife, who was then confined to her bed, could by listening with one of his instruments hear the words spoken by him in the other instrument in a distant part of the house. His son Charles was born in 1870, and if Drawbaugh's narrative is true he had succeeded at that time in transmitting speech distinctly through his instruments, although whispered words would not be accurately heard. He describes instruments which he says were made by him from time to time as experiments led him from one improvement to another. He testifies that he thinks he made his first telephone apparatus prior to November, 1866, and is positive he had it before he moved his shop to the "Clover-mill" in 1867. As he describes it, the body of the transmitter was a porcelain teacup, the diaphragm was of membrane, the electrodes interposed in the circuit were copper, with the upper one connected to the diaphragm by a wire so as to vary the pressure of a conductor of fine earth or pulverized charcoal through the action of the sound waves, and the receiver was a tin can without a top or bottom, having a membrane diaphragm stretched over one end connected by a tense cord to an armature supported on a spring and arranged close to the poles of an electro-magnet in the electric circuit. He testifies that subsequently he constructed apparatus upon the same general principle with some change of detail, and he produces exhibits "F" and "B," the former a transmitter and the latter a receiver, as the remnants of the original instruments. Exhibit "F" is a glass tumbler; and he states that at first he used a membrane diaphragm over it, and then one of thin metal, and that for the conductor he used carbons, or carbons mixed with bronze powder, and used various tops or mouth-pieces to speak into it. The exhibit "B," he says, was the receiver, and in this he had discarded the string and the spring of his earlier receiver. He says that experiment led him to improve the transmitter "F" by substituting a metal diaphragm in place of membrane, and he produces a sketch. A reproduction of this instrument has been made by him for use in the proofs, "which is designated as Exhibit F reproduced." In this the mouth-piece is modified in size and in distance from the diaphragm. He made, according to his testimony, a new receiver of more perfect construction, and produces the remnant of the original, which is designated "Exhibit C." As he describes the instrument it was a decided advance upon the former receiver. In using this he says he tested it also as a transmitter with some success, and then improved it by placing a permanent magnet against the heel of the electro-magnet, and thus made a magnetic telephone. A reproduction of such an instrument as he describes is made and referred to in the proofs as "Exhibit reproduced C." After Exhibit "C" he produces "I," "A," "E" and "D," as likewise original instruments made respectively in the chronological order of their production as exhibits. He states that "I" was used by him as a companion instrument to "C." Exhibit "A" discloses a modification of form and a higher degree of mechanical adaptation. The last two, "D" and "E," are concededly perfect, practical instruments, and according to the testimony of Mr. Benjamin, an expert witness for the defendants, would compete successfully for public patronage with any magneto telephone which had been introduced into use in 1882. It is asserted of these instruments by counsel that no higher development of the telephone has been reached at the present time than is indicated by Exhibits "E" and "D." Drawbaugh does not attempt to locate the time at which he made any of these instruments, or even the year. He testifies, however, that he made all of them prior to the time the "Axle Company" commenced business, which was in December, 1874, except "E" and "D," which were made about that time.

The theory of the defendants is, that Exhibits "F" and "B" were used by Drawbaugh in 1867, 1868 and 1869, Exhibit "C" in 1869 and 1870, Exhibit "I" in 1870 and 1871, Exhibit "A" in 1873 and 1874; and that Exhibits "E" and "D" were made in January or February, 1875, although cruder instruments essentially similar were made somewhat earlier. It is in proof that 33 patents were granted for improvements in telephones in 1878, 64 in 1879, more than 100 in 1880, and 94 in the first six months of 1881. According to the theory of the defendants, therefore, as early as February, 1875, Drawbaugh had not only distanced Bell in the race of invention, but also Gray and Edison, and had accomplished practically all that has since been done by a host of other inventors.

The case for the defendants must stand or fall by this theory. The proofs leave no room for fair doubt that defendants' contention is substantially true, or that the defense has no foundation in fact. It is true that Drawbaugh had long been treading his solitary path of investigation and experiment in poverty and obscurity, but had perfected his work when the inventions of other explorers were in embryo, or his story is an ingenious fabrication. And, as will hereafter appear, if the defense is a fabrication many disinterested witnesses have contributed innocently to give it color and strength, but Drawbaugh has deliberately falsified the facts.

The complainant starts with the benefit of the presumption of law that Bell, the patentee, was the inventor of that for which the letters patent were granted to him. Whoever alleges the contrary must assume the burden of the proof. Evidence of doubtful probative force will not overthrow the presumption of novelty and originality arising from the grant of letters patent for an invention.

It has been frequently held that the defense of want of novelty or originality must be made out by proof so clear and satisfactory as to remove all reasonable doubt. Washburn *vs.* Gould, 3 Story, 227; Smith *vs.* Fay, 6 Fish, 446; Hawes *vs.* Antisel, 2 B. & A., 10; Patterson *vs.* Duffy, 20 Fed. Rep., 641; Wood *vs.* Cleveland Rolling Mill Co., 4 Fish, 560; Parham *vs.* American Button Hole Co., 4 Fish, 482; In U. S. Stamping Co. *vs.* Jarrett (18 Blatch., 469), Blatchford, J., said the defendant had not fulfilled "the necessary obligation of showing beyond any reasonable doubt" that Weber (the alleged prior inventor) was prior to Heath (the patentee). In Coffin *vs.* Ogden, 18 Wall, 129, Mr. Justice Swayne, delivering the opinion of the Court, stated the rule applicable to the defendant as follows: "The burden of proof rests upon him, and every reasonable doubt should be resolved against him."

To overthrow this presumption and disprove that Bell was the first inventor the defendants introduce the testimony of nearly 200 witnesses tending to prove the priority of invention by Drawbaugh. As the complainant concedes that Exhibits "E" and "D" are highly organized practical telephone instruments and fully capable of perfect articulation, the patents are invalidated if these instruments were in existence at the date of Bell's invention, and as will hereafter appear they were in existence as early as in 1875, or it is incredible that they existed at all until long after Bell's first patent had been granted and his invention had attracted general public attention at the Centennial Exposition and elsewhere.

In the argument for the defendants great stress is placed upon the evidence of a gradual and natural development of Drawbaugh's invention shown by the original instruments produced, beginning with Exhibit "B" and ending with the perfect magnetos "E" and "D." It is strenuously urged that these exhibits fortify his testimony describing the instruments no longer extant, and mark the origin and culmination, beginning with the cup machine and Exhibit "F" of two separate lines of invention; one leading to the battery telephone, in which the undulatory vibrations are controlled by variations on the resistance of the circuit, and the other to the magneto-telephone in which the vibrations are created in the electromotive force of the current.

The general theory of the defense is substantiated by three classes of witnesses; those who heard of the existence of Drawbaugh's "talking machines" at various times; those who talked through the machines on various occasions or heard others talk through them, and those who attempt to identify one or more of the exhibits as the instruments they saw or used. Only an outline of their testimony will be given.

More than 50 witnesses testify to having heard of the talking machines prior to February 14, 1879.

Of these witnesses three think they heard of them in 1869; three in 1870; two in 1871; five in 1872; three in 1873; three prior to 1873; eight in 1874; two in 1875; from 1866 to 1876, one; from 1868 to 1871, one; from 1868 to 1873, one; from 1869 to 1870, one; from 1869 to 1876, one; from 1871 to 1872, two; from 1872 to 1873, one; from 1873 to 1874, one; from 1873 to 1875, three; from 1874 to 1875, one; from 1874 to 1876, one; from 1872 to 1876, one; prior to 1869, one; prior to 1872, two; prior to 1875, one.

Sixty witnesses do not attempt to identify any particular instrument, but testify that they saw a talking machine or talked through it or heard it talked through at Drawbaugh's shop on occasions subsequent to 1867, and most of them fix the occasion as prior to 1876. The substance of the testimony of some of them will be given.

Wilson G. Fox testified that he saw the talking machine at Mr. Drawbaugh's shop about the year 1867 or 1868, when the old faucet company was in operation there. Prior to March, 1871, the witness was employed in the carding room of the Harrisburg cotton mill, and Drawbaugh came there to get material to wrap his wire to use for the talking machine. Henry Bonholtzer testified that he was at Drawbaugh's shop in 1869, and saw talking machines there. Margaret Brenneman testified that she saw the talking machines at Drawbaugh's shop in 1869. Abraham May testified that he did work on Daniel Hart's house at Milltown in August and September, 1870, of which he produces his account books; that he never did any work for Daniel Hart after that; that while doing that work he was at Drawbaugh's shop to get a boring machine mended which he was using in the work and Drawbaugh showed him his talking machines, and talked through them from one floor of the shop to another. The witness understood and heard through the machines the words that Mr. Drawbaugh spoke into it. His testimony is corroborated by Jacob H. Kilmore, William H. Martin and John A. Smith. Cyrus Orris testified that he saw Drawbaugh's talking machines at different times from about the 1st of April, 1871, down to 1880, and took his son-in-law, Jacob E. Smith, to Drawbaugh's shop to see the machines about April 1st, 1871. Benjamin K. Goodyear testified that in 1871 he seized the personal property of George W. Kissinger, of Milltown, upon an execution issued November 13, 1871, that on December 4, 1871, the attached property was appraised, and on that day witness went to the workshop of Daniel Drawbaugh to find J. B. Drawbaugh to summon him as an appraiser, and had to wait for him there a short time; that while waiting there Daniel Drawbaugh showed him his talking machines, and talked through them to him, and witness heard him speak and understood distinctly the words that he spoke through the instrument; and that he was never in Drawbaugh's shop afterwards so far as he can recollect. George Natcher testifies that he lived at Milltown in 1871 and 1872, and never has been in the town since August 9, 1872; that while living there he was at Drawbaugh's shop and saw and talked through the talking machine on different floors, and listened at the same machine and understood what was said through it. Mrs. B. B. Spangler, a sister of George Natcher, testifies that she moved away from Milltown in 1872, and never has been there since; that she talked into Drawbaugh's talking machines while she lived there; and that she was so small that Harman Drawbaugh had to lift her up to enable her to talk into the machine. Mrs. Mary Free testifies that she was with her sister, Mrs. Lydia Drawbaugh, at Drawbaugh's shop in September, 1872, when he talked through the machines to them, and she remembers hearing through the machines, "Good afternoon, ladies!" Drawbaugh told them that the machines operated by electricity. Mrs. Lydia Drawbaugh testifies that she saw the talking machines in September, 1872, her sister, Mrs. George Free, being present. David M. Ditlow testifies that he saw Drawbaugh's talking machines about 1872, when Drawbaugh talked through it, and witness heard and understood through the machine what he said. David K. Ernest testifies that he was at Drawbaugh's shop with John B. Bloser about the middle of June, 1872, and talked with Drawbaugh about the talking machines, and thinks he saw them at that time. This testimony is corroborated by John Bloser. N. W. Kahney testifies that he saw the talking machines about 1872. William H. Martin testifies that he was at Milltown with John Keefauver to get George Hosler to make him a pair of boots. Hosler lived at Milltown only from March, 1872, to March, 1873. At that time witness and Mr. Keefauver went down to Drawbaugh's shop and talked through the talking machine from the basement to the attic, and heard and understood what was said through the machines. They talked and listened at the same instrument. John F. Keefauver corroborates Mr. Martin, and also states that he talked through Drawbaugh's talking machine with Jacob M. Sadler in April, 1873, prior to the death of George B. Hick, and that about two or three years before he saw the talking machines he had heard a good deal about them, and first heard of them at a place seven miles west of Carlisle. Wm. W. Snyder testifies that he was at Drawbaugh's shop on Wednesday, Feb. 5, 1873, and saw the talking machines. He verifies the date by an entry in his diary. Jacob Barber testifies that he was a candidate for the office of County Commissioner of Cumberland County in the summer of 1873, and in connection with his canvass went to Drawbaugh's shortly after the death of George B. Hick. While at Drawbaugh's shop he saw the talking machine and was never in the shop after July or August, 1873. Ezekiel Worley testifies that about the year 1873 he saw the talking machines at Drawbaugh's shop. His statement is corroborated by John K. Taylor. Abraham Ditlow testifies that he knew of Drawbaugh's talking machine in 1874, and saw it and talked through it at that time. He had forgotten the fact, but was reminded of it by Mr. Alexander Milner, of Porter County, Indiana, whom witness told about it in May or June, 1876, in Indiana. William Eppley testifies that he visited Drawbaugh's shop for the last time in May or June, 1875; that he was there several times during the two years preceding that period, and had seen talking machines. Jonathan Fry testifies that he was at Drawbaugh's shop with Mr. Hamme and Mr. Frederick in the winter of 1875-6, and saw the talking machines there. Jacob Evans testifies

that he was at Drawbaugh's shop with his wife, his brother Andrew, and his sisters Margaret and Sarah about Dec. 1, 1875, and saw and talked through the talking machines. Henry L. Hamme testifies that he was at Drawbaugh's shop either in the last of January or the beginning of February, 1876, in company with George Frederick and Jonathan Fry, and saw and talked through the talking machine at the time; that he heard and understood very plainly what was said through the machines even when Mr. Drawbaugh talked in a whisper. George Frederick testifies that he was at Drawbaugh's shop with Mr. Hamme and Mr. Fry in January or February, 1876, and saw the talking machine. S. S. Rupp testifies that he was at Drawbaugh's shop with Mr. Hamacher and his scholars on Feb. 1, 1876, and recollects that Mr. Drawbaugh at that time spoke about a machine that he had which he called a talking machine, but the witness was interested in other things and did not pay much attention to it. George H. Bowman testifies that he saw talking machines in Drawbaugh's shop in February, 1876, at which time somebody was talking to Mr. Drawbaugh through them. Charles L. Drawbaugh testifies that he saw and talked through the talking machines at Drawbaugh's shop a year or more prior to May 1, 1876, and heard and understood what was said.

The third class of witnesses are those who identify more or less positively one or more of the several exhibits as the instruments used by them or which they saw used by others prior to March 7, 1876. Exhibits "F" and "B" are identified by the following witnesses: Brooks saw them in 1874; Smyser, in 1872; Eberly, before Dec. 1870; Wagner, in the fall of 1874; Freese, in 1869 or 1870; Yetter, about Christmas, 1875; Fry, spring of 1875; Carl, in 1870; Scherick, in 1869; Balsley, between 1870 and 1874; Good, before 1872; Kahey, in 1871 or 1872; Schettel, about 1872; Nichols, in 1875; Renneher, in May, 1875; Weber, late in 1874; Stephen, before 1875; Shireman, about 1872; Hawn, about 1872; H. B. Eberly, in May, 1873; J. C. Smith, between April, 1872, and April, 1873; Sternberger, in October, 1871; Fetterow, in April, 1876; Halsinger, prior to 1876; Shoop, in 1869; H. F. Drawbaugh, in 1872; Zimmerman, in 1871; Bates, in 1874; Guistweit, in July, 1870; Hale, in fall of 1873; Stone, in June, 1871; Free, in June, 1872; J. A. Oyster, in June, 1875; Harman, K Drawbaugh, in July, 1871; J. B. Drawbaugh, in 1869; G. W. Drawbaugh, in 1870; Lenseman, in July, 1881; Fisher, in 1868 or 1869; Hubler, in fall of 1873; Updegraff, in 1874; W. H. Decker, in 1873; and a number of other witnesses saw one of these two exhibits.

The identification of Exhibits "C," "I," and "A" is made by a smaller number of witnesses. Some of them think they saw "C" in 1870 and others at various dates after that and as late as March, 1876.

One of the witnesses thinks he saw "I" in 1871, the others locate the occasions in 1873, 1874 and 1875. Some of the witnesses think they saw "A" as early as 1872, one of them in 1870, but most of them saw it they think in 1875.

Exhibits "E" and "D" resemble each other very closely in appearance, and most of the witnesses produced to identify them saw both at the same time. They locate the time as follows: Fry, laborer, in May or June, 1875; Fry, farmer, in April, 1875; Bayler, in June, 1873 (Ex. "D"); Springer, after April, 1876; Shettel, about 1875; Shoop, after February, 1877; Musser, in June, 1876 (Ex. "D"); Milliard, in 1875: Holsinger, in summer of 1875; Shoop, in 1874 or 1875: Bates, between 1874 and 1877; Dellinger, in March, 1876 (Ex. "E"); Gustweit, between 1870 and 1876; Bowen, in September, 1878; Hale, in fall of 1875 (Ex. "D"); Michael Dellinger, in November, 1877 (Ex. "D"); Harman K. Drawbaugh, in January, 1875, and helped put up wire for them; J. B. Drawbaugh, prior to Jan. 26, 1875; George W. Drawbaugh identifies all the exhibits as seen by him sometime between 1871 and 1878; Musser, in 1876; Smith, in 1872 or 1876 (Ex. "E"); Updegraff, in May, 1876 (Ex. "D"); J. H. Smith, in May, 1876 (Ex. "D"); Decker, in 1874 (Ex. "D"); Vannasdale, in Feb., 1875; Evans, in fall of 1875; Mrs. Erb, in fall of 1875; S. E. Evans, in fall of 1875 (Ex. "D"); M. E. Evans, in fall of 1875 (Ex. "D"). Some of the witnesses who identify exhibits identify the whole series. Other witnesses besides those named identify one or more of the exhibits as seen by them at times subsequent to the date of Bell's applications for his patent. Some of the witnesses who identify one or more of the instruments exhibited to them by Drawbaugh as the Exhibits "F," "B" or "C," saw or used them in 1875 or 1876. Among these are the following, to whose testimony a reference will be made:

Mr. Springer testifies that he repeatedly talked and listened with Drawbaugh through the instruments after the 1st of April, 1876, using Exhibits "F" and "B" as the instruments. Mr. Musser testifies that he talked through "F" and "B" in June, 1874; but the proofs show that this occasion was as late as in the summer of 1876. Mr. Moore, who is produced to show that Drawbaugh applied to him to acquire an interest in the invention, testifies that the talking machine which Drawbaugh produced was Exhibit "B." This was in May, 1875. Mr. Bayler testifies that he talked through "F" and "B" in 1873, but the proofs show that the occasion was between 1875 and 1877. Mr. Nichols locates the middle of January, 1875, as the time when he saw Exhibit "B" in use.

That the talking machines referred to by the witnesses were electric instruments is clearly established. Drawbaugh testifies explicitly that they were always used with a closed circuit and without breaking the current, some of them being battery telephones and some magneto-telephones. He always represented them as actuated by electricity to those to whom he explained or described them and claimed his invention would supersede the telegraph. His assertions show them to have been electrical instruments. He stated to the witness, Shauk, "It was the greatest invention ever known. If he had the means to go on with it they could talk or rather be a time to come as to talk to the old country same as we can talk here"; to Zacharias, that "he could run it out for miles and parties could talk in at one end and be heard at the other end the same as persons in a room together"; to Smith, that "parties between Harrisburg and Philadelphia could communicate as if they were speaking together; there would hardly be any limits"; it was an "instrument to convey the voice, to supply the place of the telegraph"; to Smyser, that it would work "from here to California"; to Fry, that one "can talk as far as the wire goes"; to Carl, that "he could hear a man talking from that place to New Cumberland or Harrisburg, and understand distinctly what he said"; to Sherick, that it was "better and handier than the telegraph; that you could just talk through it in place of writing"; to Blasley, that "by attaching two wires you can hear it away off; the telegraph is nowhere with it"; to Kahney, that "he could talk the same for miles as he could for short distances"; to Shettel, that "if he had a wire from the shop in connection with the telegraph wires at White Hill he could talk to Mechanicsburg by having a machine there or an instrument in the office; that it would be better than telegraphing, and that it would be worth a great deal of money"; to Reneker, that "he thought he could make it that he could talk through to Harrisburg; he thought they would take the place of telegraphing"; to Weber, that "it beats all the others of my inventions; he could carry sound, or rather talk as far as Shiremanstown"; to Hawn that "he would be able to operate, that a man preaching in New York, that a congregation in Philadelphia would hear the same sermon"; to Kahney, that "he could just as easy speak ten miles as one, or any distance he would choose to"; to Rupp, who was there with Hamacher, that "it was worked by electricity; would take the place of the telegraph, and that he could make it so that he could talk to San Francisco"; to Musser, that "he was going to make a machine to talk from Harrisburg to Philadelphia, and it would be a cheaper and quicker way than telegraphing"; to Smith, that "he believed they could talk for a hundred miles"; to Fetterow, that "I could speak ten, fifteen or twenty miles, or even to California if there was a wire extended"; to Wisler, that "he could attach a wire to it and talk for ten miles, as far as he could have a circuit around"; to H. F. Drawbaugh, that "he could talk across the continent"; to Free, that "the talking machine could be used to talk at a long distance, from Philadelphia to California"; to Landis, that "it could be used a thousand miles; it would take the place of the telegraph"; to Lenig, that "he could talk hundreds of miles through that"; to Updegraff, that "instead of using the old mode of telegraphing, he could talk directly through the wire; he thought he could talk as far as you could use the ordinary telegraph wire"; to Draper, that "he thought it was or would be one of the greatest inventions of the age, and would take the place of telegraphing"; to A. Evans, that "he could take this machine and talk clear out to Europe across the ocean"; to Eicholz, that "if he could only get some one to help him once he would run it to Harrisburg and convince them, and then he would run it from Harrisburg to Philadelphia. He stated to the witness Shank that "it works by electricity"; to Smith, that "it was by electricity"; to Nichols, that "the sound was conducted by electricity"; to C. Eberly, that "the instruments were to convey sound by electricity"; to Coudry, that "they were operated by electricity"; to Shoop, that "it operated by a battery"; to Shireman, that "they operated by magnetism"; to Hawn, that "they would be operated on by a battery"; to N. W. Kahney, that "the machine was operated by electricity by a battery"; to Zimmerman that "it was electricity that would pass it over the wires; that it would carry the sound right along"; to Hale, that "it was driven by a magnet"; to H. K. Drawbaugh, that "the sound could be carried to a distance on a wire by the use of electricity"; to Lenig, that "electricity was used in connection with it"; to Prof. Heiges, that "in connection with a talking machine both magnetism and electricity were applied"; to Goodyear, that "his talking machine was also done by electricity over wires"; to Woods that "it was to be an electric machine used in place of telegraphing"; to Young, that "it was an electric talking machine which he had invented."

Thus Drawbaugh is corroborated by a cloud of witnesses whose testimony tends to substantiate his narrative. Without stopping at this point to consider the credibility and probative force of their testimony, it suffices to state that although some of the witnesses seem to have been reckless and unscrupulous in their statements the great body of them are undoubtedly honest witnesses. It is impossible, however, to believe that Drawbaugh can be mistaken in the substance of his testimony, and the conclusion cannot be ignored that either his testimony is true in its essential parts, or his narrative has been manufactured to fit the exigencies of the case. In order to ascertain what effect is to be given to the corroborative proofs it is important to determine whether Drawbaugh is an honest witness or whether he has intentionally falsified collateral facts, and is therefore to be deemed discredited.

If the defense is to be believed, he had been experimenting with his talking machine from 1866, and had successfully transmitted speech as early as 1870, if not before that time. He testifies that he had used Exhibits "B" and "F" in transmitting speech for two or three years before he made Exhibit "C." According to the theory of the defendants Exhibit "C" was made in 1869 or 1870. At that time he had reached a secondary stage in the development of his invention, and certainly as early as in 1872, when Exhibit "C" had received its latest modifications, the invention had passed out of the period of rudimental forms embodying principle merely into a form embodying nice details of construction and had reached a perfection not reached by Bell in his earlier patent. Drawbaugh was well aware of the merit and of the great pecuniary value of the invention; he had obtained patents for several inventions of minor value, yet from 1870 until July, 1880, he did not apply for a patent for the telephone. It was of the first importance to explain the reason of his inaction, because it seems incredible that the inventor of the telephone should not only omit to patent it as soon as he could, but should also remain silent for years after others were winning the fame and profits of the invention. Only one explanation was possible, and that has been attempted. As stated in the answer and in his testimony, it is that he was unable to do so by reason of his poverty. The answer alleges "that for more than ten years prior to 1880 he was miserably poor and utterly unable to patent his invention or caveat it." He was asked the question: "Do you mean to have it understood from your last answer that there was any other reason for some period prior to 1870, except your poverty, whether greater or less, which prevented you from patenting your invention, or filing a caveat for it?" His answer was: "If I understand that right, there was no other reason that I can think of now." He proceeds to state that Exhibits "F" and "B" exhibited the principle perfectly enough to patent. In the elaborate efforts of the defendants to substantiate the theory of Drawbaugh's inability from poverty to patent his invention, much testimony has been produced to show, and which does show, that he was always more or less in debt, often a borrower of small sums of money, was dilatory in paying his debts and used to plead his inability when dunned, and was often sued and judgment and executions were obtained against him, but it is clear from a few plain facts that the theory of extreme poverty is unfounded, and that Drawbaugh is dishonest in putting it forward. In 1867 and 1869, besides what he received for his wages, he received $5,000 from the Pump Company for his faucet invention, besides $1,000 in the stock of the concern. On the 1st day of April, 1869, he received $1,000 from one Gardner for the sale of a half interest in a faucet invention. He invested $2.000 of the $5,000 in real estate, lost $400 of it in an apple speculation, and used the $1,000 received from Gardner to buy a house and lot for his father. Between 1867 and 1873 he paid $1,200 to the Drawbaugh Manufacturing Company for assessments on his stock, besides $870 in labor; and in July, 1873, received from that company $425 cash in settlement of its affairs. From 1867 to April, 1872, he was the owner of real estate for which he had paid $2,300 in the fall of 1867, and upon which he expended in improvements in the spring of 1868 from $300 to $400, and which was encumbered only by a prior lien for $300. In the spring of 1872 he encumbered it for $1.000, not as a principal but as a surety. He was in receipt of $110 annually, as rent for a part of this property, occupying the rest himself, until he sold it in 1876 and bought another house in the town of Mechanicsville. He was always in receipt of fair wages for his labor. From April 1, 1875, to April 1, 1876, he received nearly $450 for wages from the Axle Company, irrespective of his earnings from other sources, and declined steady work at times because he could make more by job work. Thus it appears that, although it was not convenient at times for him to pay his debts, or he was careless or indifferent, he had not only the means of raising money during all this period, but that on many occasions he had means for investment and for speculation. The pretense that he could not raise the fees to caveat or patent his invention is transparently absurd.

He was accustomed to prepare specifications of patents, and was a maker of models, and advertised himself as an inventor, designer and solicitor of patents. During the time he was experimenting on his talking machine, and before he applied for a patent, he found time and materials for experimenting with and making the Gifford injector for steam engines, the autograph telegraph, the magneto-dial telegraph, the magneto key, the automatic fire-alarm and the electric clock. During this period he was a friend of Mr. Weaver, a patent solicitor, who frequently gave him advice and professional assistance in return for mechanical services rendered by Drawbaugh, and who drew specifications for him for a measuring faucet and for the magnetic clock. If he was not competent himself to make an application for the patent, it cannot be doubted that with the assistance of Weaver he could have made a proper application at a trifling outlay, if any, beyond the fees of the office.

Drawbaugh devoted a good deal of time between 1867 and 1878 to the invention and construction of his electric clock, and the time and money expended by him in experimenting and constructing this clock in its various forms, especially those made in 1877, 1878, was much more than would have enabled him to patent his talking machine. These clocks were built by him with his own tools and out of his own money, and to build them economically he made a gear cutting machine, which must have cost him more than it would to patent his telephone. In April, 1878, he received $500 from the Electric Clock Company for the privilege of using his clock invention.

In order to fortify the theory of Drawbaugh's inability from poverty to patent his invention the defendants have attempted by testimony from him and from others to show that he was extremely solicitous to patent it, and tried to induce others to furnish the means. Mr. Springer testifies that "his (Drawbaugh's) whole mind appeared to be on his talking machine: he told me that many a night he didn't sleep just studying how to improve it." After May, 1872, according to the testimony of Jacob Hawn, the talking machine superseded the clock in Drawbaugh's interest. According to Mr. Holsinger, from 1873 to 1876, "he appeared to be crazy on it; I often tried to get information from him on other subjects and about half minute's talk would turn him right on the talking machine." Henry F. Drawbraugh, his brother, testifies, "Every time I was down there from the summer of 1872 to 1879 or 1880 he was working at it and talking, and wanted me to go in with him and furnish means." Mr. Bates says he was in Drawbaugh's shop eight or ten times between the summer of 1874 and the fall of 1877, and "his general conversation was about the talking machine; said he would like to get it patented but had not the means, and could make a fortune out of it." Drawbaugh testifies as follows: "Question. A good many witnesses have testified that you were at various times talking of patenting your electric speaking telephone invention; what is your recollection about that, did you intend to patent it or not? Answer. Yes, sir, I intended to patent it. I had spoken to a number of persons to assist me. I would state to them that I would give them an interest in the invention for them to furnish the money to have it patented. Question. Why did you not patent it with your own money? Answer. I did not have any money. Question. At how early a time did you have the intention of patenting it? Answer. I could hardly say how early. I spoke to persons even at an early time. I spoke to Christian Eberly; it may have been prior to 1870 I spoke to Frank Lee; I spoke to them about taking an interest. They were among the earliest. I can't remember all the persons as I had spoken to a great many." Lee is not a witness, having died in 1872. Christian Eberly locates the time as between 1867 and 1870. He had been a partner with Drawbaugh in a number of inventions and was a capitalist. He was asked: "When Mr. Drawbaugh showed you his talking machine state whether he proposed to you to go into partnership with him and furnish the money for that also as you had before that time on the other inventions?" He answered: "Not altogether; he intimated that he would take me in. I don't recollect as I said anything, or what I said." The witness was often in Drawbaugh's shop subsequently, in 1871, 1872 and 1873, but mentions no other propositions. The only other persons Drawbaugh specifies as having been applied to by him are Capt. Moore, Henry Bayler and Simon Oyster. Oyster was not called as a witness. Captain Moore was examined as a witness for the defendants and his testimony is significant. He was the principal of the Soldiers' Orphan School, an institution in the vicinity of Eberly's Mills, and was the secretary and treasurer of the Axle Company, a concern that in part occupied Drawbaugh's shop in 1875 and 1876. He testifies that in May, 1875, Drawbaugh showed him a talking machine; said he was unable to patent it himself, and desired witness to "go in with him and get a patent." He states that he told Drawbaugh he didn't want to go

into any new inventions, but that it would be a fortune to any person bringing it out if it could be put to practical use. He identifies Exhibit "B" as the machine shown him at that time by Drawbaugh. Although he and Drawbaugh maintained intimate business relations for a year after that time the subject seems never to have been referred to again. Mr. Moore was an intelligent capitalist. It is strange that Drawbaugh should have shown him Exhibit "B," the crude instrument of 1867–1869, if the perfect instruments "E" and "D" were in existence; and more strange that the subject was never mentioned again between them if they had any faith in the value of the invention. Mr. Bayler, the other witness, carried on lumbering and a saw-mill from 1873 to 1877 in the vicinity of Milltown and employed Drawbaugh frequently to repair machinery. He testifies that in June, 1873, Drawbaugh showed him the talking machine, and he said to Drawbaugh, "Why, Dan, that is virtually a talking telegraph," and advised him to take out a patent for it, to which Drawbaugh replied: "If I had the means I would; if you'll advance me the means to procure a patent I'll give you a half interest." The witness continues: "Generally on him meeting me he would urge it, urge me to take an interest by furnishing him the means to take out a patent." He also identifies exhibits "F" and "B" as the instruments shown him by Drawbaugh. But his books show that during all the time from April, 1873, to May, 1876, he owed Drawbaugh more than the fees necessary for producing a patent.

The defendants produce other witnesses to prove that from 1870 to 1879 Drawbaugh was showing his telephone, adverting to his poverty, and trying to induce somebody to assist him. Mr. Herr may be cited as in illustration. He testified that in 1870 or 1871 Drawbaugh wanted money to get a caveat to secure his invention, and told the witness if he would help him or procure any person to assist him he would give him a half interest. Without adverting further to the testimony on this subject it is sufficient to say, in view of the fact that there never was a time from 1867 to 1880 when Drawbaugh did not have the money to caveat and patent his invention or the means of borrowing it, the only legitimate effect of such testimony is to discredit the whole defence by exciting the suspicion that it is bolstered up by exaggerated and unreliable testimony. It will hereafter be shown that, among the men with whom Drawbaugh maintained business and friendly relations during this period, there were many of intelligence and means. Some of them may have distrusted his judgment and regarded him as a visionary. Some of them may have been indifferent or timid. But it is incredible that, when only a trifling sum was required for a half interest in the invention, none of them could be sufficiently impressed with its merit or financial value to investigate it seriously as a speculation or an investment. He induced persons to invest in faucet inventions and in his magnetic clock; and it cannot be true that he could find no one to entertain the talking machine which, according to the common rumor of the neighborhood, was to supersede the telegraph, and, in the words of one of the witnesses, "make Drawbaugh one of the richest men in Cumberland Valley." It was very natural that a hard-headed old farmer like William Daer, on being told by Drawbaugh that he had a machine by which he could talk across the Atlantic Ocean, should advise him to "try it first in talking across the Yellow Breeches Creek," but it is beyond comprehension or belief that none of the capitalists or speculators about him could be induced to seriously consider it if it was an operative device.

Where a witness falsifies a fact in respect to which he cannot be presumed liable to mistake, courts are bound upon principles of law, morality and justice, to apply the maxim "*Falsus in uno, falsus in omnibus.*" The Trinidad, 7 Wheat., 283. Drawbaugh could not be mistaken in asserting that it was his poverty which prevented him from caveating or patenting his invention. He was not led to the assertion inadvertently. Those with whom he is associated in the defense understood fully, and so did he, that the fact that a professional inventor and patentee did not go to the Patent Office to secure an invention like the telephone for ten years after it had been completed and demonstrated was almost conclusive against the theory that he made the invention and that unless this presumption could be parried no court would credit his story. The theory of constraining poverty was therefore formulated in the answer, elaborately fortified by witnesses, and testified to by Drawbaugh. It is overthrown by a few plain, indisputable facts, and Drawbaugh's veracity falls with it.

The defense must rest upon the testimony of the witnesses who corroborate Drawbaugh. The case made by these witnesses is sufficiently formidable to overcome the legal presumption of the validity of the complainant's patents. It is met by the complainant with rebutting evidence, direct and circumstantial, showing the intrinsic improbability of the theory that Drawbaugh was the inventor of the telephone, and showing his conduct or declarations inconsistent with any hypothesis that he was more than an unsuccessful experimenter with the invention. Many witnesses have also been produced by the complainant to attack the credibility and reliability of the testimony of the defendants' witnesses. Of necessity the testimony of most of the defendants' witnesses can only be attacked by showing that witnesses are mistaken as to the time when they saw Drawbaugh's talking machine, or as to what they really saw on the occasions they refer to. The way in which the testimony of Uriah P. Nichols is met will illustrate the general tenor of such testimony. Mr. Nichols was one of the most intelligent and trustworthy of the defendants' witnesses, a farmer and machinist, who testified that on the 18th day of January, 1875, he visited Drawbaugh's shop on business, saw two instruments which he identified as Exhibits "B" and "A" and described their mode of operations as stated to him by Drawbaugh at the time; he says he listened at one instrument while a boy spoke into another two hundred feet away, connected by wires, and heard the boy say: "Is it you, father, speaking?" The complainant produces nine witnesses to show that the occasion could not have been prior to February, 1878. The witness fixes the date by a purchase of lime made by him on the visit, and states that he went to Drawbaugh's to see an electric clock of which he recently read a description in a newspaper, and soon after the visit told Mr. Maish and others about the telephone he had seen at Drawbaugh's. The complainant proves that the newspaper article was not published until February, 1878; that when the witness told Mr. Maish of the telephone at Drawbaugh's the latter, who was then a member of Congress, remembered the occasion, knew all about Bell's telephone at the time and had used it in Washington. Mr. Maish states that as Drawbaugh was one of his constituents he would have been deeply impressed by the conversation if he had understood Drawbaugh claimed to be the inventor. Without attempting to particularize the rest of the testimony for the complainant upon this issue, it suffices to say that several other witnesses were introduced to show that the lime was purchased by Nichols in 1878. Much testimony is given by complainant upon collateral issues of a similar character. One of these issues relates to the time when Thomas Draper ordered a hydraulic ram of Drawbaugh. Mr. Draper was an important witness for the defendants. He testified that he went with Mr. Kissinger, a tenant of his, to Drawbaugh's shop in May or the early summer of 1874, for the purpose of ordering of Drawbaugh a hydraulic ram to be used upon the farm Kissinger had leased of him in April, and that he was never at Drawbaugh's on any other occasion. He identified Exhibit "C" positively and Exhibit "I" less positively as the instruments used and through which he listened while Drawbaugh talked. The complainant proved that the hydraulic ram was not put to use until the fall of 1878, and undertook to locate the date of Draper's visit approximately by that fact. Seventy-five witnesses were introduced by the respective parties upon this collateral issue. These illustrations show how hopeless a task it would be to review the testimony satisfactorily or analyze it minutely. Five hundred witnesses have been examined by the parties upon the main question and the collateral issues, and their testimony is in a printed record of over six thousand pages. If it were practicable to do so it would not be profitable, because a microscopic view of the controversy would be inadequate and misleading. In cases where such a chaos of oral testimony exists, it is usually found that the judgment is convinced by a few leading facts and indicia outlined so clearly that they cannot be obscured by prevarication or the aberrations of memory. Such facts and indicia are found here, and they are so persuasive and cogent that the testimony of a myriad of witnesses cannot prevail against them.

The first group of facts of this nature are those which bear upon the capacity and character of Drawbaugh as an inventor, and tend to show that it is not only highly improbable but almost impossible that he could have been the author of the telephone.

In the summer of 1878, he composed a biography of himself for publication in the history of Cumberland County, which presents a graphic picture of the inventor and of the man. He commences by describing himself as "born in the quiet, secluded village of Milltown, three miles from Harrisburg," and as one of the greatest inventive geniuses of this age, who has spent the greater part of an active life conceiving and producing as the result of the conceptions of an unusually fertile brain as score of useful, ingenious machines and devices. It appears, he says, "by examining a list of his inventions that the manufacturing interests of the place in his boyhood days gave direction to his thoughts and incentive to his action." He proceeds to enumerate a list of his inventions as follows: "His first invention was an automatic sawing machine; then a number of machines used in wagon making; then a machine for boring tenets; then a machine for sawing tenets; a barrel stave jointing machine, patented 1851—This machine was pretty generally introduced and its merits appreciated; an automatic grinding-machine was next invented to meet a demand created by the introduction of the jointer; then followed several machines for making stave headings and shingles, all of which were patented in 1855; after which machines for rounding, heading, crozing, dressing and finishing outside of barrels were invented; these were again followed by device for running mill-stones, one for dressing mill-stones, a device for elevating grain in mills. He then invented and had patented four improvements in nail-plate feeding, next a tack machine and a new design in tacks. Photography next engaged his attention. He fitted himself for action in this field by manufacturing his own camera, ground and fitted achromatic lenses for camera, prepared the necessary chemicals and improved the process for enlarging pictures. Next electricity and electric machinery attracted his attention, and an electric machine was produced throwing out of consideration the galvanic battery and electric pile; then a machine for alphabetical telegraphing; then the justly celebrated electric clock and the machinery necessary for its construction; and several kinds of telephones, one of which is operated by battery and another by induction." He concludes as follows: "It will be seen from the foregoing that Mr. Drawbaugh has penetrated vast fields in search of information, and with what success we leave the reader to determine. We are proud to own Mr. D. as a citizen of our township, and deem him worthy of a position at the head of our prominent men, and are happy to accord him that position." This portrait, drawn by himself, depicts without the aid of extrinsic evidence the ignorance and vanity of the man, and the incongruous and fantastic assortment of his inventive projects. It suggests also the character of a charlatan.

That he was a skillful and ingenious mechanic is undoubtedly true. Invention was his hobby and his vocation, but that he was an inventor in the large sense is disproved by the nature and results of his work. Every patent that he obtained was for some improvement on existing devices which involved mechanical skill rather than any high degree of inventive faculty. This is shown to some extent on the face of his patents, the list of which is as follows:

November 11, 1851, "for improvement in stave jointing machines"; May 22, 1855, "for stave machine"; April 28, 1864, "for improvement in mill-stones"; May 12, 1863, "for improved machine for leveling the faces of mill-stone"; December 12, 1865, "for improvement in nail plate feeders"; November 20, 1866, "for improvement in faucets"; November 19, 1867, "for improvement in nail plate feeding device."

His own testimony, given in an interference proceeding in the patent office in 1869, shows that none of his inventions were sufficiently meritorious to prosper vigorously. That proceeding involved a question of priority of invention between himself and one Hauck, respecting an improvement in a faucet. He had filed his application for a patent in January, 1879, and undertook to carry back the date of his invention to 1869. The scope and range of his inventive faculty became a subject of inquiry. He there testified that he had made he might say fifty inventions and had patented over a dozen. He was cross-examined respecting certain inventions to show that they did not work satisfactorily. He was then asked: "Since 1866 what machines have you conceived and perfected that have worked satisfactorily?" He answered: "To the best of my knowledge I think they all have. The nail machine gave satisfaction. I had it running in the works, but the nailers drove it out. The tram and red-staff was a good machine and adopted by a number of millers. The magnetic clock I consider a good thing, but I am not through with experiments on it yet. I believe this last faucet to be a good thing." If his nail machine had induced the workmen to drive it out of the shop it ought to have commended itself to the capitalist. His magnetic clock had not been patented at this time, though it had been for a time the wonder and admiration of the community in which he lived; but when it was patented in 1879, it was a "new article of manufacture," consisting of a galvanic battery for electrical clocks which had two old elements united instead of being disconnected as in former devices. The history of his clock shows clearly that it was of no practical merit; and the clock had been substantially described in Tomlinson's Encyclopedia, and he had the book before he made his alleged invention. His other electrical devices he never patented, and in his testimony in the interference proceedings he did not refer to them as among his perfected and successful inventions. One of these was his magneto electric machine for short line telegraphing and fire-alarms, sometimes mentioned as his magneto key. It was not a new device, and the proofs show that it was a failure.

When the speaking telephone was first introduced to the attention of the scientific public it was pronounced by one of the most eminent electricians of the day "a result of transcendent scientific interest" and "the greatest by far of all the marvels of the electric telegraph." The inventions attributed to Drawbaugh include not only the conception of the principle of the unbroken, undulatory electric current and of the delicate and complex instrumentalities essential to its efficient application in transmitting and reproducing articulate speech, but also of many other devices involving a nice adjustment of forces and requiring sensitive mechanism. These were inventions of a peculiarly scientific order which would seem to demand a special conversance with the principles of acoustics and electricity. Besides making the cardinal discovery of the theory of the unbroken undulatory current, Drawbaugh is assumed to have perfected a brilliant and extraordinary series of original discoveries for which, to use the words of Mr. Benjamin, "there is no parallel instance in the whole history of invention." Mr. Benjamin, referring to the microphone which was introduced to the public in 1878, by Mr. Blake, but which is one of the instruments asserted to have been invented by Drawbaugh at an earlier date, says: "It was looked upon as a great and original discovery."

It was said by Chief Justice Taney (O'Reilly *vs.* Morse, 15 How., III.) speaking of the invention of the telegraph: "No invention can possibly be made consisting of a combination of different elements of power without a thorough knowledge of the property of each and the mode in which they operate on each other. For no man ever made such an invention without having first obtained this information, unless it was discovered by some fortunate accident." None of Drawbaugh's alleged discoveries were made by accident. His statement is that, starting with the belief that speech could be transmitted by electricity, he made first one contrivance and then another, gradually obviating difficulties and making advances experimentally until he finally perfected the several inventions.

In view of Bell's special equipment for investigation and experiment in electrical and acoustic science it would not seem strange that his persistent efforts tried to effect the electrical transmission of speech were eventually successful were it not that others as intelligent, as well equipped, as ingenious and as persevering as he had devoted years to the same object in vain. He had the assistance of Mr. Watson, an expert in electricity and a skilled workman in electrical mechanism, in constructing the apparatus employed in his experiments, and who also aided him in his experiments. He had demonstrated his inventive proficiency by inventions in telegraphy for which patents were granted to him. And yet had it not been for an accidental discovery made by him in June, 1875, and which would probably have escaped one whose trained faculties were not centered on a careful study of the phenomena, he might have failed.

Drawbaugh, on the other hand, was not only untutored but he was isolated by his associations and occupations from contact with men of advanced science; he had narrow opportunities for instruction and few incentives for profound research. Among the multitude of his inventive conceptions was one that a talking machine was a possibility. According to the testimony of Lory, a witness for defendants, before Drawbaugh began his practical experiments he exhibited a sketch of a machine that he was about to make that would talk a distance of twenty miles and work something like a telegraph. If this is true he commenced on his telephone as the architect plans a building or the engineer makes a draught of his structure. His own testimony shows that he did not attempt to qualify himself for electrical inventions by any systematic study after he began experimenting with his talking machine. Although he had undoubtedly acquired considerable desultory information about electricity, and especially about the mode of operation and detail of construction of electrical mechanism, it is obvious that when he commenced with his talking machine he was a tyro in electrical science, essaying the most difficult work of the electrician. It is almost incredible that the subtle intellectual discoveries which were a closed book to the ablest electrician could have been reached by a smatterer in science, or by any series of empirical experiments.

As has been remarked, he seems to have discovered nothing accidentally, yet from the beginning to the end of his narrative there is nothing to indicate the conceptive origin or the mental growth of the alleged invention. He presents a number of devices in the chronological order of their production, and testifies that he made one and then another and another, as experiments led him to modifications and improvements. He cannot describe what receiver or other apparatus he used with his first transmitter, and testifies: "I had a number of crude apparatuses, but can't remember exactly the shape of any of them. I had membranes stretched over hoops—over a hoop, I remember that; and I had electro-magnets, and the arrangement was varied; I don't remember exactly the arrangement." He testifies that when he used the cup machine he used it in a continuous electric circuit, and thinks he used it as a receiver with Exhibit "B" as a transmitter. He states that he succeeded in transmitting speech with these two instruments, and, of course, he could only have done this

by employing the unbroken undulatory current of electricity. He cannot state how he conceived the initial ideas of the undulatory current and the continuous circuit, or subsequently the theory of any of the remarkable devices which he produces. His answers to questions intended to elicit such information may be illustrated by giving one of them: "I don't remember how I came to it; I had been experimenting in that direction; I don't remember of getting at it by accident either; I don't remember of any one telling me of it; I don't suppose any one told me." He produces sketches or models or originals of instruments which he says he made from time to time; he states that they were used to talk through on various occasions; and from these outlines of accomplished facts leaves the history of his inventions to be filled out by inference and conjecture. An inventor can hardly forget the process of thought by which a great intellectual conception germinates and matures into the consummate achievement; but Drawbaugh's memory is a blank. If the untutored mechanic educated himself into an accomplished electrician by his own experiments and observations the incidents and phenomena which revealed new discoveries and illumined the way for new advances would be indelibly impressed upon his mind. It seems little short of the miraculous that a man of his capacity and equipment should have produced these inventions at all; more marvelous still that he should have produced them without any intellectual perception of his discoveries.

Another group of important facts which are satisfactorily shown by the proofs are those which indicate Drawbaugh's own knowledge that he was not an original inventor of the telephone. Reference has been made to some of the evidence bearing upon his neglect to patent or caveat his invention in discussing the question of his credibility as a witness.

If no honest and reasonable explanation can be given for his conduct, the inference is very strong that he knew he did not have a practical telephone to patent. He may have had a talking machine which was well calculated to excite the curiosity of the community in which he lived; he may have indulged in expectations that in time he could succeed in making a practical speaking telephone, and reap fame and profit from it, but his conduct is almost decisive against the supposition that he had even deluded himself with the belief that he had produced anything sufficiently practical and valuable to patent. He never attempted to exhibit it outside of his own shop to prove that it would transmit speech at a distance of even a quarter of a mile. The proofs show that during all the years from 1867 to 1878 he did not attempt to avail himself of opportunities for demonstrating his invention and bringing it to the notice of friends who were peculiarly qualified to appreciate, and were favorably circumstanced to assist him. One of these persons was Mr. Kiefer, who resided at Harrisburg from 1863 to 1881, and during that period had charge of the telegraphs of the Pennsylvania Railroad Company, and was a member of a firm whose business was the manufacturing of fine electrical machinery. In 1873 he put up a fire alarm system for that city. Drawbaugh made his acquaintance in 1874 or 1875 and brought his magneto fire alarm to Mr. Kiefer for examination. At another time he brought the works of his electric clock. He visited Mr. Kiefer on various occasions, obtained small supplies from him, and habitually conversed with him upon the subject of his electrical contrivances. The period of these visits begins just about the time when according to the theory of the defendants Drawbaugh had constructed Exhibits "E" and "D" and the invention was complete. He never mentioned to Mr. Kiefer the fact that he had experimented with a telephone. Mr Wilson was superintendent of telegraphs for the Northern Central Railway Company at Harrisburg from 1864 to 1875. He was also Mayor of Harrisburg. The company had an electrical workshop and supply establishment there for Mr. Wilson's department between 1871 and 1875. During this time Drawbaugh often came to the supply shop and talked with Mr. Wilson about electrical experiments and obtained parts of batteries, coils, magnets, and other electrical material which the company had cast aside. He brought Mr. Wilson his electric clock and his magneto-electric key, and tried his machine for short line telegraphing at Mr. Wilson's office; he talked with him frequently about his inventions, but he never mentioned the telephone. His relations with David A. Houck were such that the latter procured him an opportunity to test his magneto key at the telegraph office of the railroad company at Mechanicsburg. Mr. Stees was the superintendent of a car company at Harrisburg, having shops in different parts of the city connected by telegraph lines. He was the first person to employ Bell's telephones on these lines when they were introduced into Harrisburg late in 1877 or early in 1878. He was a friend of Drawbaugh, and Drawbaugh would naturally have applied to him if he wanted to test his telephone publicly or practically. Isaac Lloyd was a school teacher and an alderman at Harrisburg; had known Drawbaugh long; was accustomed to visit his shop from time to time; saw many of Drawbaugh's inventions; was present on one occasion when Drawbaugh experimented with his magneto device for telegraphing at Mr. Wilson's telegraph office. Drawbaugh visited him frequently, and they were accustomed to converse about Drawbaugh's inventions. Drawbaugh showed him his dial telegraph, his electric fire alarm apparatus and numerous other inventions. Witness assisted him about the electric clock. He was an owner of patents and a friend to whom Drawbaugh applied for loans, and was interested in mechanical subjects generally. The only mention ever made to him by Drawbaugh about a telephone was in 1878 when Drawbaugh told him he was experimenting with a telephone. From 1867 to July 1873 Drawbaugh was intimately connected with the persons composing the Drawbaugh Manufacturing Company, which was engaged in manufacturing devices under Drawbaugh's patents. He was a stockholder and the master mechanic of this company. Among the officers and stockholders were many men of capital and enterprise. There came a time when the managers of the company wanted Drawbaugh to suggest new devices for the company to manufacture. He never suggested the telephone nor attempted to induce the managers of that company to investigate or exhibit his talking machine. A number of the managers and employees of this concern testify that they never heard of the existence of the talking machine during the life of the company. Without attempting to refer to other testimony to the same general effect, what has already been referred to shows that if Drawbaugh had seriously desired to bring his talking machine into public notice and secure the fruits of his invention he had ample opportunity to do so. Who can doubt that if he had a practical telephone to exhibit he would have selected just such men as Kiefer, Wilson, and the others to demonstrate it to them and enlist them to demonstrate its utility and value to the public.

Such an invention was of a kind well calculated to excite public interest, and to impress practical men with a quick appreciation of its commercial importance and its pecuniary value. It was sufficiently perfected, according to the theory of the defense, that a patent could have been obtained prior to 1870 to secure the application of the principle, and to compel every subsequent inventor to pay tribute to the discoverer of a new art. For years it was mechanically perfect, and its efficiency and importance as a great factor in human intercourse could have been demonstrated to the public without appreciable inconvenience or expense. Drawbaugh fully appreciated its importance and value. He had the means to patent it himself and friends to assist in introducing it into public use. He had the talent to induce others to invest in his inventions. No explanation is possibly why, under such circumstances, his efforts should have left no mark upon the annals of inventive progress, and given no evidence of life beyond the idle curiosity his talking machine excited in the circle of his admirers during all these years. His conduct is more persuasive to show that he did not have a practical, operative telephone than the testimony of a multitude of witnesses who may have seen and heard talking machines at his shop during this period. But the complainant has given evidence of his declarations made by him before he had any interest to pervert the truth which afford a reasonable explanation of his conduct and go far to explain how the testimony of the corroborative witnesses may be reconciled with the truth.

In 1874–6 Drawbaugh issued a business card advertising himself as "Inventor, designer and solicitor of patents." On the back of this card is printed a list of his inventions as follows: Stave heading and shingle cutter, barrel machinery, stave jointing machine; tram and red-staff for leveling face of mill-stones; rine and driver for running mill-stones; nail machinery for feeding nail plates; pumps, rotary and others; hydraulic ram, the Drawbaugh rotary measuring faucet; carpet rag looper, electric clock and magneto-electric machine for short line telegraphing and fire alarm and propelling electric clocks. He takes pains to say of this magneto machine on his card that it can be applied to any form of electric movement, and dispenses with a galvanic battery. He had obtained patents for some of these inventions but had not for others. He was then experimenting with his electric clock and with his magneto machine for short line telegraphing, fire alarms, etc., and including them in the list of his inventions. The omission to mention the most important one of all of his inventions, one respecting which, according to his present testimony, there had not been a week from the time he made his first cup machines that he had not been engaged with it, one which was complete before his electric clock was complete, is a significant statement by implication that he had no such invention to advertise.

It is to be remembered that when he chronicled his achievements in the autobiographical sketch of 1878, the Bell telephone had been introduced into commercial use at Harrisburg, three miles from Drawbaugh's shop, and the local newspapers had been full of the subject. The cursory allusion in that autobiography to "several kinds of telephones" is in striking contrast with the elaborate description of the electric clock, and wholly inconsistent with the theory that he deemed himself to be the originator of the invention which at that particular time was a topic of universal interest.

In his testimony given in 1879 in the interference proceeding with Hauck, although he did not include the talking machine in the category of his successful inventions, in the course of his testimony he produced a sketch of his faucet, and stated that he made it "about 1874 to 1876 when I was experimenting on telephones or phonographs." He represented himself not as an inventor of that which he is now claimed to have perfected, but as an experimenter with a "telephone or phonograph." It is instructive to read this statement in juxtaposition with a statement made by him to Mr. Matthews in the preceding year. Mr. Matthews was the managing editor of the *Baltimore American*, and in April, 1868, made a visit to Drawbaugh at his shop to see Drawbaugh's magnetic clock in consequence of information received from a correspondent. He was a careful observer who went there obviously for the purpose of writing an article for his paper. That his memory is unusually retentive and accurate and that he is a careful and conscientious man is apparent from a letter written by him in December, 1883, after the proofs in the case had been closed, and in which he manifests a desire to correct certain errors of detail in his deposition. Upon that visit his attention was chiefly directed to the clock, but he examined Drawbaugh's other inventions, and conversed with him about them, and, among other things, conversed about the telephone. Drawbaugh's statement to him on that occasion was that he had invented apparatus to send messages by means of an alphabet founded upon difference of sounds. He did not profess to be the inventor of the speaking telephone, or assert that he had ever transmitted speech successfully with his apparatus. He said that the idea of transmitting sounds in this manner was not new, and he had read of it some years before in a publication translated from the French, and denied Bell's right to claim the invention of the telephone, because of that publication. In the article founded on that interview which Mr. Matthews subsequently wrote for publication in the *Baltimore American* he adverts to the several useful agricultural and mechanical devices patented by Drawbaugh, and adds: "It may be mentioned that Mr. Drawbaugh constructed a rude telephone long before Mr. Edison loomed up as the 'boss' inventor. He never expected to send articulate sounds over a magnetized wire, but he believed that an alphabet could be arranged after the manner of the musical scale, and that messages could be transmitted and understood by the variations of tone and pitch. This unlettered mechanic came very near anticipating Edison and Bell in the invention of the telephone, and nothing but his poverty prevented him from conducting his experiments to a successful issue."

His advertising card, his testimony before the Patent Office, his autobiography, and his statement to Matthews authenticated in writing were all made when he had no pecuniary interest to color the facts, and upon occasions when he was anxious to present himself in the most favorable light as an inventor; and they were all made after his talking machine, according to the theory of the defendants, was a perfected invention, and known to be such by many of his friends and neighbors.

These are declarations evidenced in writing, and one of them made under oath, which point in but one direction. They are consistent with his conduct. They show that he understood himself to be an experimenter with telephones or phonographs, but not the inventor of the speaking telephones.

The complainant has supplemented this evidence by the testimony of other substantial witnesses who had favorable opportunities to know what Drawbaugh had invented, and who describe what they saw and did not see at his shop, and narrate what he said about his talking machine on various occasions. This testimony indicates that at as late a period as in 1878–79 Drawbaugh was an experimenter, but not the author of the parent invention, nor one who had perfected any valuable improvement upon it; and is in substantial accord with his statement to Mr. Matthews and his testimony in the interference proceedings. What gives point and force to this testimony and carries the ordinary objections to the reliability of verbal declarations is that these witnesses are persons who would have been forcibly impressed because of their interest in the particular subject by any assertion by Drawbaugh that he was an inventor of the telephone. During the time in question Drawbaugh had friendly relations with the newspapers of the vicinity; his friends were frequently communicating laudatory notices of his mechanical and inventive efforts to the press, and he himself visited one of the newspaper offices in the spring of 1878 to show a telephone he had made. These newspapers had published articles about the Bell telephone, but up to the spring of 1878, while many notices had been published in them about his electric clock and other inventions, describing him as a man of extraordinary genius, there had been no mention of the telephone, and when, in the spring of 1878, the subject was mentioned, he was referred to as one who was "inventing a telephone on a different plan from that now occupying the attention of the scientists," and as about completing the new telephone he is now constructing.

In this connection it is to be noted that, soon after telephones were introduced in Harrisburg late in 1877 or early in 1878, Drawbaugh visited the offices where they were used, examined the inside of the instruments and borrowed one to take home, which he kept for several days; and the instrument which he borrowed bears a close resemblance in appearance to Exhibit "A," which, it is asserted he had made in 1873 or 1874.

No extended reference will be made to the testimony of other witnesses such as Mr. Weaver and Mr. Grissinger, showing declarations of Drawbaugh made after the Bell telephone was in commercial use, to the effect that, although he had experimented on the telephone years before Bell, he had obtained no satisfactory results.

It remains to consider what effect is to be given to the testimony of the multitude of witnesses who have been produced to substantiate the defense.

Disregarding the testimony which is merely hearsay, and therefore incompetent as evidence of the main fact, the testimony of many other witnesses is overthrown by the palpable improbability of their statements, or by the contradictions between their statements and those of other witnesses for the defendants upon substantive points, or by successful attacks upon their accuracy in the rebutting testimony of the complainant.

There still remains a formidable number of witnesses who testify to seeing or using Drawbaugh's talking machine, and some of whom identify particular exhibits as the instruments which they saw or tried.

No doubt is entertained that Drawbaugh was experimenting at an early period with telephones or phonographs. He knew about the phonograph or phonautograph of Scott as early as in 1863. The membrane diaphram excited by sonorous waves and the electric mechanism of the phonograph were not novelties, and, among the diversity of inventive possibilities, had probably attracted his interest. Prior to 1869 Dr. Van Der Weyde had made public experiments with the Reis telephone at the city of New York, and others had made like experiments elsewhere. In May, 1869, a full description of the instrument and of the experiments was published in the newspaper, *The Manufacturer and Builder*, treating it as a highly interesting curiosity, which contained the germ of great practical purposes. Whether other newspapers noticed the experiments or not is not shown, nor is it shown that Drawbaugh saw the article in the *The Manufacturer and Builder*. It would be difficult to prove the circumstance if he did see it. Some such publication probably stimulated him to experiment. If he made a sketch of the mechanism at the start the material for it was at hand. As is stated by Mr. Benjamin, it has been asserted of the Reis instrument that certain sounds of the human voice can be transmitted by it, but in truth these are merely fragmentary reproductions of vocal sounds, and the transmission of articulate speech could not be effected because it was constructed on the make and break principle, instead of on that of the undulatory, unbroken current.

It is not strange to any reader of the autobiography, that Drawbaugh should have taken up the telephone. That he, and those about him, should have treated it as a talking machine is entirely natural. That his talking machine as late as in 1876 bore a striking resemblance to the Reis telephone is shown by Mr. Shapley's testimony, a witness who noticed the resemblance and loaned Drawbaugh a copy of the *Scientific American* describing it.

There is enough here to explain Drawbaugh's declarations to his neighbors about the talking machine he was inventing, and to excite the curiosity of the community. A careful reading of the proofs, render it easy of belief that the witnesses who testify about casual visits to his shop, which occurred many years before their testimony was delivered, and to cursory tests of his instruments on those occasions, have confused the fragmentary and incoherent articulation of such an apparatus with the hearing of distinct words and sentences. When witnesses undertake (as many of them do) to give the exact word or sentence heard in the instrument five or ten years before, when their attention was not called to the subject afterwards, no hesitation is felt in rejecting such statements as utterly incredible. It may be charitably inferred that such a witness has confused his recollection with more recent impressions. As will hereafter be shown, the proofs demonstrate that most of the witnesses who testify to having heard distinctly and coherently through the talking machine, all those who indicate the exhibits "B," "F" and "C" as the instruments, are mistaken if they are truthful.

If Drawbaugh was a charlatan, he may have assisted in deluding them, and the proofs show that between 1872 and 1874 a string telephone was in his brother's shop, in the village The fact that he never attempted to exhibit his machine outside of his shop, where it could be used between points some considerable distance apart, and where its real capacity could be readily observed, is significant in this connection.

The more important testimony is that by which it is sought to identify the several exhibits, and show their existence at times consistent with theory of the natural evolution of the invention. The identification of particular exhibits as seen by the witnesses among the various objects of curiosity at Drawbaugh's shop several years before they testify is necessarily unreliable when it is attempted by observers who had no knowledge of the mode of operation or of the internal organization of the instruments. Such witnesses could not appreciate what they saw even if they examined the instruments. Most of the witnesses belong to this class. Indeed, the greater portion of them do not profess to identify the exhibits positively. Some are more certain than others that particular exhibits are the instruments they saw. Exhibits "F," "B" and "C" are fragmentary remains of instruments, and their value depends upon Drawbaugh's description of the operative parts that no longer exist. Scores of witnesses testify to seeing the teacup device resembling Exhibit "F," and the tin can device resembling Exhibit "B," but the identification of the other exhibits prior to the date of Bell's patent is comparatively feeble.

The appearance of Exhibits "F," "B" and "C" is sufficiently peculiar and distinctive to impress the memory of those who saw them. On the other hand the other exhibits are not of this character, and all that ordinarily the witnesses can safely say of them is that five years or more before testifying they think they saw or used a small walnut box externally resembling "I" or "A" or "E" or "D."

It may be said generally of all the testimony of the witnesses who attempt to identify exhibits, that it is mainly valuable when it proceeds from those who used the instruments which they think they remember, and obtained results. They must remember the results obtained much better than the minor differences of appearance presented by the instruments. Granting that Exhibits "F," "B," and "C" would be likely to be remembered, what shall be said of the value of the testimony of scores of witnesses who state that they tested these instruments, or saw others test them, and they articulated perfectly, when it appears by the most authentic test that these instruments were incapable of such articulation.

In March, 1882, after most of the proofs in the case had been taken, a test was made of the capacity of the Exhibits to transmit speech in the presence of the counsel and the experts for the respective parties. It is not accurate to say a test was made of the Exhibits, but reproductions of "F," "B" and "C" were made by Drawbaugh, and as rehabilitated by him, were used for the test. Whether these were honest reproductions no one can tell, but such as they were they were experimented with by Drawbaugh before they were subjected to the test. Whatever else that test demonstrated, it proved that articulate speech could not have been practically communicated through Exhibits "F," "B" and "C" at Drawbaugh's shop or under similar conditions; and that only fragmentary or incoherent speech could be occasionally and exceptionally rendered by the reproduced instruments which had been experimented with privately before the public test. The proofs show that all along to 1878 Drawbaugh exhibited his earlier instruments "F" and "B" to spectators, and used them as his talking machine, sometimes showing or using both together, and sometimes one of them. The testimony of the defendant's witnesses, Springer, Moore, Musser and Bayler is pertinent upon this point, and has been referred to. How is it to be explained that he used these crude instruments in 1875 and 1876 as his talking machine if he had the better instruments, especially such instruments as "E" and "D"? But in view of the fact now shown that these earlier exhibits are incapable of satisfactory articulation, what confidence can be placed in the rest of the testimony produced to identify exhibits? If the witnesses are mistaken in identifying these very characteristic instruments and in recalling the results obtained through them little reliance can be placed upon the identification of the other instruments or upon the statement of the results which the witnesses think were obtained through them. If these witnesses are mistaken in the dates which they fix for the occasions they speak of their testimony can be reconciled with all the probabilities of the case. And the reasonable explanation of their testimony is that those witnesses who really saw or used the latter exhibits did so in 1876, 1877, 1878, and later, instead of on earlier occasions.

The proofs on both sides lead to general conclusions that Drawbaugh was not an original inventor of the speaking telephone, but had been an experimenter without obtaining practical results until the introduction of the instruments into Harrisburg. It is very probable that after reading in the *Scientific American*, loaned by Mr. Shapley in October, 1876, the article purporting to describe Bell's telephone, but which really described better the Reis apparatus, he undertook to improve his old devices. At that time, or after, he had examined the telephone instruments at Harrisburg and carried one of them home to study, he may have altered the organization of his instrument, and made the intermediate exhibits between "F" and "D." If he exhibited them at his shop, and was able to transmit speech through them, this fact will account for the testimony of the witnesses who identify those exhibits, and may be mistaken as to the time they saw them. The real history of his talking machine is known only to himself, and will not be profitable to conjecture when he made the advanced instruments which he claims to have made in February, 1875, and the later instruments.

It may be that in discrediting his narrative and rejecting the theory of the facts which rest upon it, the value of the corroborative testimony has been under estimated. However this may be, no doubt is entertained as to the conclusion which should be reached upon the proofs.

Succinctly stated most favorably for the defendants the case is this: One hundred witness more or less testify that on one or more occasions which took place from 5 to 10 years before, they think they saw this or that device used as a talking machine; they are ignorant of the principle and of the mechanical construction of the instruments, but they heard speech through them perfectly well and through one set of instruments as well as the other. This case is met on the part of the complainants by proof that the instruments which most of the witnesses think they saw and heard through, were incapable of being heard through in the manner described by them, and further, that the man who knew all about the capacity of his instruments never attempted to use them in a manner which would demonstrate their efficiency and commercial value, and on the contrary, for ten years after he could have patented them, and for five years after they were mechanically perfect, knowing all the time that a fortune awaited the patentee, and with no obstacles in his way, did not move, but calmly saw another obtain a patent and reap the fame and profit of the invention.

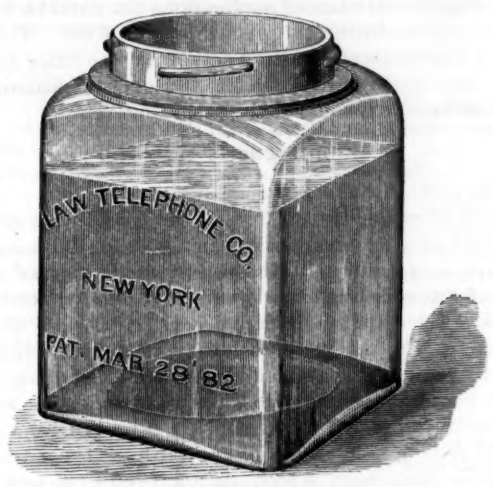
Without regard to other features of the case it is sufficient to say that the defense is not established so as to remove a fair doubt of its truth; and such doubt is fatal.

The observation of an eminent commentator may be quoted as apposite to the case: "No form of judicial evidence is infallible, however strong in itself; the degree of assurance resulting from it amounts only to an infinitely high degree of probability, and perhaps as many erroneous judgments have taken place on false or mistaken direct testimony as on presumptive proof." Best's Evidence, § 468.

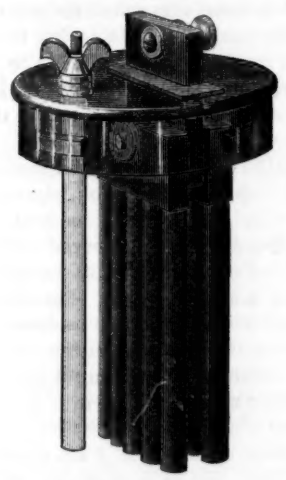
A decree is ordered for complainant.

The New "Law Prism" Battery.

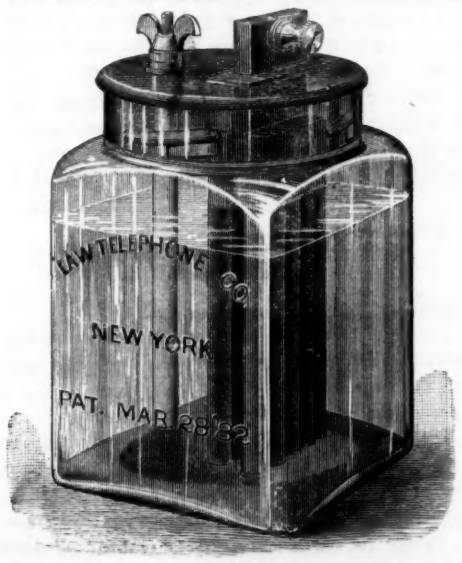
We illustrate on this page the new prism battery, known as above, of the Law Telephone Co., the sole manufac-



turers, 112 Liberty street. The sealed top, or lock top, keeps the solution from evaporating, so that the battery remains "set up" at least half as long again. This is a special point of merit for tropical or sub-tropical service in



which the solution is likely to dry up very quickly. No paraffine is used in sealing. Owing to the corrugation of the carbons, as seen in cut, double the surface is exposed to the action of the solution. There is no need to



screw the top to get it on, as just a slight turn will secure the glass top against a pure rubber ring, entirely excluding air. These are all points tending to increase indefinitely the longevity of the battery, and the lock top is practically indestructible. It may be noted, too, that the constituent elements, zinc, carbon and sal ammoniac, are carefully analyzed before being put into the battery. A report from the well-known chemists, Stillwell & Gladding, says that the zinc rods contain no copper—iron 0.106, and zinc 99.894. The size of the battery, over all, is $4\frac{1}{2} \times 4\frac{1}{2} \times 7\frac{1}{4}$.

"Skeered" of Suspenders.

Food, drink, dress and every detail whereby we live, move and have our being, have been at some time or other the subject of debate and attempted revolution, and now the hitherto respected, much relied on and considered innocent suspenders, the "gallusus" of our forefathers, are arraigned as enemies to health and life. We quote from a letter, the writer of which, being a newspaper man, can be endorsed as a second G. W. for veracity:

I received a unique circular the other day inviting me to become a member of a society by the payment of a small initiation fee. I have received similar circulars in the course of my life, but never have I found any quite so peculiar as this, issued as it was by no less remarkable a body than "the society for the alleviation of human misery and for the eradication of the original causes of those ills of mankind which are directly traceable to the death dealing rules of fashion, and especially to the pernicious habit of wearing suspenders with straps crossed at the back." This precious title is followed by a recitation of some of the reasons for the abolition of suspenders. It is gravely alleged that the habit of wearing any suspenders at all is contrary to all the teachings of antiquity and the experience of ages. Adam, in his palmiest or most figleafy days wore no suspenders, and one may search the history of all time in vain to find a hero or a martyr rushing to a glorious doom incumbered with those useless and "effeminate straps." And so it goes on at some length, only to close with a startling scientific statement:

"On the crossing of many suspenders," it says, "a piece of brass or other metal is fastened to add greater strength to the infamous contrivance. This bit of metal when brought into opposition to the gold or silver watch chain on the front of the body is apt to give rise to a voltaic current not strong enough to be perceptible, but which in time acts on the kidneys and liver to such an extent that these organs become semi-paralyzed. and, losing their vitality, degenerate and give rise to the many diseases which carry off so many unfortunate victims." The headquarters of the anti-suspender society is in Philadelphia, where it is stated that it has 36 members, 33 of of whom, I grieve to say, are women—all of whom prefix Mrs. to their names. Probably the maiden of the mild-mannered town below Germantown Junction recognizes the motive to matrimony furnished by missing buttons. and withholds her coy consent to signing the articles of the society. In any case, what right have they know anything about suspenders, anyway?

Extra Brilliancy, Economy and Safety.

The columns of this journal have contained so frequently an enumeration of the advantages of the electric over all other lights that repetition is unnecessary, but the following, from an English publication of the highest class, and not interested specially in electrical science and its application, is an endorsement of very considerable value. *The Mechanical World* of Nov. 13, 1884, in discussing, editorially, the electric light, says:

There are, without doubt, numerous cases in which the electric light can not only be used more economically than gas or oil—that is, with regard to the total amount of illumination given out—but where it is, in addition, possessed of a far more important quality, that of (comparatively) perfect safety. The most notable instance of this will occur at once to the reader's mind, since for use on board steam ships, whether passenger or cargo boats, this form of illumination stands unequaled. There can be little or no doubt that the recent destruction, by fire, of the steamship *Maasdam* (caused, it is said, by a naked light being brought too near the cargo of petroleum oil), might, nay would, have been entirely averted had only the vessel been provided with glow lamps, and the needful machinery for their maintenance. Apart, therefore, altogether from their superior lighting power and consequent greater comfort, the item of safety is a still stronger argument for their use in comparison with the often dangerous and always unpleasant oil lamps, which the public and those who live on the sea have for too long endured. We also note a recent installation of glow lamps in a large distillery, where constant care had previously been needful in the use of gas, by reason of the inflammable spirit fumes evolved during the process of distillation. For all such purposes, therefore, this method of lighting cannot be too highly recommended; and when, as we believe is the case in this instance, there is a clear monetary profit to be obtained by its use, one would be tempted to consider the tradesman or manufacturer extremely short-sighted in failing to avail himself of such advantages. In all manufactures where mineral oils are used, in sugar refineries (for the vacuum pans, for example), in the majority of textile factories, and in countless other places of industry, we are convinced that electric lighting will be found to give the greatest benefits with the fewest risks.

Strange Peril and Brave Rescue.

If any writer of fiction were to represent one of his characters as clinging to the top of a telegraph pole whilst in the throes of an epileptic fit, that author would be judged as guilty of inventing impossible situations for the sake of sensationalism. But in Brooklyn, on Monday morning last, Frank Allen, a lineman of the N.Y. and

Telephone Company, climbed the pole (one of the largest size) at York and Washington streets. Another lineman, Thomas Fitzpatrick, assisted him from the street to repair the wire damaged by the storm of the night previous. Suddenly the man at the top was seen to stop work. His head fell forward, his legs twitched convulsively, and his body swayed so violently that every instant the spectators below expected to see him tumble headlong into the street. Fitzpatrick, who had been climbing during the morning, and had his spurs on, realized in an instant that his comrade had been seized with a fit. Snatching up a leather belt, such as linemen use, he jumped on the pole and climbed as he had never before climbed in his life. It was a question of seconds, and although the ascent of 80 feet was made in less than half a minute, it seemed an age to those who watched the swaying body of the man in peril.

A cry of horror went up from the crowd as the body on the crossbar lurched heavily forward, while Fitzpatrick was yet several feet from the top, and for an instant it seemed as if help would have come too late, but just as Allen sank into unconsciousness, and his convulsive grasp was relaxed on the crossbar, Fitzpatrick's muscular hand seized him firmly by the collar. With great skill and courage, Fitzpatrick, while supporting his own weight by twisting his legs round the pole and burying his spurs in the timber, took from his waist the belt which he had carried up and strapped his comrade to the crossbar. He then shouted for a long ladder. One man ran to Truck No. 3 of the Fire Department, the house of which was near by, and in a few minutes the machine came rattling down the street. Expert hands placed a great ladder against the pole and before it was properly in position a nimble fireman had clambered up half its length. With the aid of the fireman, Fitzpatrick carried his still unconscious comrade to the ground. Both the rescuers were wildly cheered as they reached the foot of the ladder. Allen, who recovered consciousness in a few minutes, was taken to his home at No. 52 Tillary street. He was dazed, however, for some time, and could hardly realize the great peril from which he had so narrowly escaped. He has been a lineman for several years, and never before had a fit.

Is there no society, anxious to recognize heroism, to present Fitzpatrick with a life-saving medal?

Since the above was written Allen has died.

The Associated Press on the Defensive.

The charges and criticisms made against the Associated Press, asserting partisanship and criminal manipulation of the figures in election dispatches during the late campaign were so frequent, violent and serious, that a meeting of the Joint Executive Committee of the New York Associated Press and the Western Associated Press was called in this city to investigate and take action in the matter. The heads of the great newspapers of the country compose this Joint Committee and represent every shade of political opinion.

The investigation was thorough and included circulars of instruction, correspondence with agents by letter and telegraph, correspondence with candidates of both great parties and complaints from all sources, despatches sent out, returns received by telegraph, and the originals filed by the senders in the several telegraph offices.

It is unnecessary to give the lengthy report drawn up by a sub-committee and signed by Charles A. Dana, N. Y. *Sun*, Chairman, and Whitelaw Reid, N. Y. *Tribune*, Secretary, but the document seeks to exonerate fully the Associated Press officials and agents from every charge of dishonesty or attempt to deceive the public or hold back the results of the election. It states that "the work, strictly confined within the limits prescribed by rules which experience has proved to be safe and just to all parties, has been larger than in any previous campaign; that while "there were some serious errors in telegraphing our reports, especially from remote points, there was but one error of importance in the office of the Associated Press, but it was corrected as soon as its inaccuracy was positively ascertained," the committee finding "no evidence of an intentional wrong-doing on the part of the sub-agent. From first to last there was no effort to control or affect the returns by any member of the committee in any interest, nor any interference of any sort, and the general instructions under which the work was done were strictly fair, non-partisan, and more thorough and minute than ever before."

Electrical Exhibition Prizes.

It is already well known that prizes were promised by the Franklin Institute and THE ELECTRICAL WORLD to the successful essayists among the pupils of the Philadelphia public schools who sent in compositions on the objects seen at the late Electrical Exhibition. The distribution of the prizes took place on Thanksgiving night, Nov. 27, at the Girls' Normal School, Seventeenth and Spring Garden streets, Philadelphia. The Institute prizes consisted of handsomely engraved diplomas, together with small, square leather cases, in each of which was a new $5 gold piece. The President of the Institute, Mr. W. P. Tatham, was in the chair. Addresses were made by Col. Banes, who stated that over 13,000 children had visited the Exhibition, and by Dr. W. H. Wahl. Eighty Institute prizes were awarded. The two general prizes offered by THE ELECTRICAL WORLD were given as follows: $15 to Oscar P. Chamberlain and $10 to Miss Maggie Sproul, whose essays were the best in the whole lot. These essays were then read, and both evinced great intelligence and powers of perception, as well as of description, on the part of the authors. The distribution of the prizes was watched with great interest and pleasure by a large number of the friends of the pupils.

The Work of the Patent Office.

Below are some of the principal statistics from the annual report of Commissioner of Patents Benjamin Butterworth:

Number of applications for patents received	35,204
Applications for design patents received	1,322
Applications for re-issue patents received	244
Applications for registration of trade-marks	1,077
Applications for registration of labels	975
Total	38,822
Caveats filed	2,672
Patents granted, including re-issues and designs	22,822
Trade-marks registered	903
Labels registered	833
Total	24,558
Patents withheld for non-payment of final fees	21,613
Patents expired	10,230

The receipts from all sources were $1,145,433, an increase of $49,948 over the preceding year. Expenditures (including printing) $901,513; surplus, $244,019. Increase during 1884 over the number of applications for patents, designs, etc., received during the preceding year, 3,088. The number of applications awaiting action by the office June 30, 1884, was 9,186, an increase of 5,088 over the accumulated applications at the end of the preceding year.

Non-Magnetic Watches.

To the Editor of The Electrical World:

SIR: In your issue of Nov. 15, an article appeared on the subject of non-magnetic watches, and the assertion is made that the ordinary Waterbury watch is proof against the influence that has nearly ruined so many costly time pieces. The question propounded as to how we shall account for its non-magnetizability is an interesting one, and were it not for the fact that a person can buy one of these watches cheaper than to have any appliance added to his watch to prevent magnetization, I presume the subject would receive more attention than it has. Those who have carried a Waterbury watch do not need to be told that it contains a very long spring, but perhaps even some owners of this now popular cheap timepiece are not aware that this main-spring lies just inside the outer edge of the case and extends *entirely around the movement*, its length allowing it to make several convolutions about the running parts. While the position of the spring may have no tendency to prevent magnetization, still in the absence of proof as to what *does* protect the movement, may we not reasonably look in this direction for it? Some three years since I saw in a manufactory in this city a device intended to demagnetize watch movements. It consisted of a padded clamp in which to secure the watch, placed on the face of a small gear wheel, which was caused to revolve at a terrific rate of speed by being geared into larger wheels, the balance wheel of the watch to be operated upon first being blocked by a slip of paper. The speed attained was several thousand revolutions per minute, but even this failed to remove the magnetization or to prevent its presence if the machine were brought into close proximity to a dynamo while running. From this fact, coupled with a sad experience while testing the above appliance with a valuable timepiece of my own, I am constrained to reject the suggestion that the fact that the Waterbury movement revolves once in an hour may account for its non-magnetizability. Speaking of the length of spring in the Waterbury, I may remark that a certain young man in the employ of our company winds his Waterbury before leaving for home at night by gripping the winding stem in a chuck on a quick-running lathe, and holding the movement fast while he kicks the treadle a given number of times. This shortens the operation of winding so much that he is not obliged to leave business early, in order to get his supper and complete the evening task of winding his watch up before late bedtime.

FRANK G. LYON.

NEW YORK, Nov. 25.

"Motorman."

To the Editor of The Electrical World:

SIR: I note with much interest the continuance of the subject to which I referred lately in your columns. The views of the two journals from which you quote are certainly pertinent, although in many respects unjust. The *Mechanical World*, especially, criticises electrical nomenclature with altogether too sweeping a hand; while the *Iron Trade Review* airs its ideas in a way which sounds a trifle arbitrary. In both cases, however, the tone of the articles is to be excused on the ground of insufficient knowledge. The words "ohm," and "volt" are not new, although it is quite within the limit of possibility that each has but recently found a place in the vocabulary of the two journals in question. The terms "ampère" and "coulomb" also express certain well-defined ideas, which had to be expressed by something, and the fact that they are objected to by "Mechanical Journals" detracts nothing from their usefulness.

But such a compound abomination as the word I lately attacked should meet with no mercy; and I haste to "shake hands over the bloody sarcasm" of "motoneer," with my respected coadjutor "Ampère," whose letter I was pleased to read in your issue of Nov. 29.

He has argued so ably on the right side, that I have much pleasure in forgiving the Parthian arrow which he aimed at my defenceless "Mouton." And by the way, that same shot, so replete with the delicate sarcasm of Rabelais, makes me see stars, and gives me a clue to the identity of "Ampère."

Yet, agreeing as I cannot but do with the general tenor of "Ampère's" communication; since I have lance in rest, I must needs take issue even against *his* proposed compromise of motorman.

If he simply means that the attendant of a motor, whether an electro-motor, a water-motor, an air-motor or any other may be and should be entitled a "motorman" I have no dispute with him; but in that case no new distinguishing term is necessary.

If on the contrary he would have us understand that the attendants of electro-motors only are motor-men, I have no hesitation in saying that I think him wrong; inasmuch as such a proposition implies that electro-motors have a substantial monopoly of the term "motor," which the facts of the case do not warrant.

I am very sure that "Ampère," on re-consideration, will not wish to say "I am père to motorman."

There can be no objection in calling the attendant the "motorman." when there is any necessity for calling him anything. Neither can there be any objection to calling the attendant of an elevator a "motorman."

But there can be and is an objection to implying that there is but one motor, and electricity is its prophet.

NEW YORK, Nov. 28. THOS. D. LOCKWOOD.

The Nomenclature of Electricity.

To the Editor of The Electrical World.

SIR: Permit me to encroach once more and only once on your valuable space. In your issue of Nov. 15, I made a suggestion in regard to supplying a word to fit into a niche I felt there was need to fill up. The note has called forth a number of letters and wise suggestions.

There is no question but that the nomenclature of electricity, by its very magnitude, will bring far more trouble than have all the other sciences. The natural sciences are packed with both sensible and senseless generic and specific terms and words. However the world has a right to suggest and a right to slash, and the combinations arrived at have made our language.

Obviously, it is well to have reason and a foundation for our words. I claim both for "Motoneer." Its derivation and termination are common, plain and pure. For one reference I use Worcester, Mr. Lockwood is welcome to his Webster.

Your editorial in the issue of Nov. 22 was most timely, most excellent and to the point. Mr. Lockwood's letter was entertaining and instructive. My experience in life has been that it is far easier to tear down than to build up. Will Mr. Lockwood help me to build up a brief and pure electrical lingo? He would have done better to have suggested a better word or a remedy. He really must be fertile in such matters, judging by his able writings. On first reading the conclusion of his article I thought he was going to look up "Daft" and suggest it. I could not entertain for a moment the thought that so scholarly a gentleman intended anything personal; it was so far from the point. I admire his "second thought," and feel quite confident that when it comes relative to "motoneer" he will be as strong *pro* as now *con*.

GREENVILLE, N. J., Dec. 2. GEO. W. MANSFIELD.

The Popularity of Copper Wire.

To the Editor of The Electrical World.

SIR: Being aware of the interest shown in the Provinces as well as in this country, in what may be developed from the uses and experiments with copper wire as an electrical conductor, I am exceedingly pleased with Mr. Wm. Maver, Jr.'s, article, or the first installment of it. In my estimation it has enhanced the value of the journal much. We require just such terse, clear explanations of the practical parts of the science. The language cannot be mistaken, even by a novice. Of course the higher mathematics and theories of the science must be shown, but at the same time each copy of an electrical journal might contain one article upon the plain and practical aspect of each system embodied in the science of electricity, and may Mr. Maver favor us frequently.

LOWELL, Mass. H. R. BRISSETT, M. D.

BROTHERLY-LOVE ITEMS.—Philadelphia's councils passed, last year, an ordinance ordering the removal of all telegraph and telephone poles and overhead wires, before Jan. 1, 1885. On Nov. 26, the time was extended twelve months from that date; but to balance this concession, one of the stern city fathers "went for" the companies, and had prepared an ordinance repealing all the franchises granted to the telegraph and telephone companies, which paid their license charges under protest, and then sought the aid of the courts to enable them to have a portion of the money refunded to them. To the Baxter Overland T. & T. Co. and to the Morse Underground Conduit Co. was granted permission to lay under-surface cables, but the like privilege was denied the Cosmopolitan Underground C. Co., while the right to all streets granted the Brooks Co. was sent up for investigation, as was likewise the offer of the curbstone conduits of C. H. O'Byron, offered to the city as a gift.

THE TELEGRAPH.

TAKING IT OUT OF THE OPERATORS.—Latest advices from the South state that the W. U. General Superintendent, J. Merrihew, is making a tour in the cause of economy on behalf of the company. In Mobile, Ala., he discharged one receiving clerk and reduced to just one-half the salary of the one retained; all operators were placed upon salary, and extra pay was abolished. The same sweeping measures, it is stated, were to be carried out in New Orleans.

A NEW TELEGRAPH CO.—The Atlantic Telegraph Co. has been formed at Biddeford, Me., with the following officers: President, Hon. John J. Donovan, Lowell; Vice-President, Hon. J. W. Deering, Portland; Secretary, N. D. Pratt, and Treasurer, T. G. Gerrish. Board of Directors, the officers of the company, Hon. Stephen J. Abbott, of Waterville; Hon. George P. Wescott and Payson Tucker, of Portland; Hon. Frank Jones, of Portsmouth; Weston Thompson, of Brunswick; Francis Jewett, of Lowell, and E. A. Leslie, of New York. The capital stock of the company has been fixed at $100,000, divided into 4,000 shares. The company is chartered to operate lines within the State of Maine, and will be ready for business between Boston and Portland, early next spring, and the large towns and cities throughout the State soon after.

THOSE TROUBLESOME "TICKERS."—The latest move in the Chicago Bucket Shop war has been made by the Stock and Produce Exchanges of New York and Chicago. The Western Union Telegraph Co., which controls the Gold and Stock T. Co., claims to be now, as always before, willing and anxious to remove the *casus belli*, those troublesome "tickers," now in possession of the outside barbarians, the Bucket Shop men. But the latter are strongly fortified behind legal entrenchments and vow as roundly as their aristocratic opponents that they will fight it out on that line forever, and so it appears that the W. U. T. Co. is not to have a renewal of its contract with the Chicago Board of Trade, and the Produce Exchanges have to make other arrangements for receiving telegraphic quotations. It is a three-cornered kind of a fight in which all parties get hurt.

THE TELEPHONE.

A RESIGNATION.—Mr. A. A. Coburn has resigned as a director of the Erie Telephone Co.

FRENCH TELEPHONY.—Paris, Bordeaux and Lyons show only a proportion of 14 telephone subscribers to every 10,000 inhabitants, while Rheims contains 210 subscribers, being 23 telephone users out of each 10,000 citizens.

ENTERPRISING CANADA.—Montreal has completed her Fire Department Telephone System, but its benefits will not be at the disposal of the general public as the apparatus will be used only for communications between the different stations.

AS A FIRE-ALARM.—The telephone has been most beneficially used in Paisley, Scotland, for calling out the fire brigade. In one case the apparatus arrived two minutes after the telephone summons, and a most extensive fire was prevented in a large dye works by the brigade's speedy arrival in answer to a call from the local telephone exchange.

BELLICOSE.—Another war is threatened; the Rocky Mountain Bell Telephone Co. in Salt Lake City has, it is stated, received notice from the headquarters office at Boston, that the decision of the celebrated Drawbaugh suit was to be immediately followed by legal proceedings against each and every subscriber to the Molecular Telephone or other infringing instruments.

TROPICAL TELEPHONING.—Authentic reports from Mexico represent the telephone business as in a very promising condition. In the City of Mexico, Nov. 1st, there were 560 subscribers, and when the town of Guadaloupe is connected, as it soon will be, the subscription list will be so increased that the Mexican company will immediately be able to pay expenses, and also to show a moderate profit. In Guadalajara the company has 158 subscribers.

GROWING IN GLASGOW.—Communication between Glasgow and Paisley, Greenock, and Edinburgh, has been established by the National Telephone Company, Limited, of Glasgow, and shortly the system will be extended to Hamilton, Coatbridge, Dumbarton, Falkirk, Grangemouth and Bo'ness. Liberty is to be given to non-subscribers, in all these places, to use the telephone for a small fee and telegrams will be received from or transmitted to the P. O. department by "word of mouth."

TELEPHONING FROM THE DEPTHS.—The divers employed in raising the vessel *La Provence* from the bottom of the Bosphorus, were telephonically connected with their comrades on the water surface. A telephone was inserted in a copper plate which replaced one of the helmet glasses, and by slightly turning his head the diver could communicate with those above and receive instructions. Added to the great facilities for hastening and aiding work, is the protection afforded to those who work beneath the waters, they being at once able to report an accident and summon aid.

THE ELECTRIC LIGHT.

MR. J. J. SKINNER has recently resigned his position as Secretary of the Thomson-Houston Co.

ENLIGHTENED BRITISH BAKERS.—Incandescent electric lamps are now used by English bakers for lighting the interiors of ovens heated to 600 degrees Fahrenheit.

LIGHT FOR THE TICKERS.—The Great Northwestern Telegraph Co. have placed in their Montreal operating room and business offices the electric lights furnished by the Royal E. L. Co.

THE EXCELSIOR CO have secured the contract for lighting the large new dry goods store in Fulton street, Brooklyn, of Wechsler & Abrahams, with 75 arcs, of 2,000 c. p., and 100 incandescents, both kinds on same circuit. Four 25-light dynamos will be used. The order for 900 arc lights for the New Orleans Exposition and the thirty 30-light dynamos has been completed and shipped in four weeks.

LOWELL (MASS.) E. L.—By the annual report of Mr. J. H. McAlvin, treasurer of the Middlesex Electric Light Co., it appears that there are 276 lights in use, 185 of which are in stores, etc. Of the 15,000 shares valued at $10 each, 1,894 remain unsold. This company does not intend to remove its works; the present station is sufficiently large, convenient, and in every way suitable, the property being valued at $90,000.

IN THE NEW YORK PUBLIC SCHOOLS.—The Board of Education, New York City, on Wednesday, 3d inst., adopted the report of the Auditing Committee recommending the adoption of the contract with the Edison Electric Light Co., for 190 lamps of 16-candle power each, to illuminate Grammar School No. 35 for the evening high school. The company is to furnish the plant, necessary materials and work to light the building for the sum of $2,600.

A PLEASING PROSPECT.—At the last meeting of the English Edison and Swan United Electric Light Co. in London, the chairman, Mr. J. S. Forbes stated that the effect of the Electric Lighting Act and the Provisional Order was equivalent to rendering electric lighting impossible. Nevertheless, as an offset to the large loss of last year, amounting to £28,000, the first quarter of the present financial year exhibited a profit of £750 on the credit side, and prospects for the future were continually brightening.

EYE-GUARDS AGAINST E. L. RAYS.—Any danger to the eye that may arise from use of the incandescent light would likely be caused from the red or heat rays, and like trouble from the arc lamp occurs from excess of blue or actinic ray. To protect the eyes of persons who are in the habit of working by or with electric lights, Dr. W. H. Stone, F. R. S., has devised a pair of spectacles set with front glass of blue and attached side glasses of red. The tints of the glasses are selected and combined by help of the spectroscope, and in looking at the incandescent light through the blue glasses the glare is removed and irritation from the intense yellow and red rays prevented, while after folding down the red side glasses over the blue front ones the arc light can be looked at with safety through the joint media.

WATER POWER WELL UTILIZED.—By placing a dam across the Valserine, a stream yielding 1,110 gallons per second, and a hydraulic power of over 2,000 horses through a 165 ft. fall, M Dumont, manufacturer, of Bellegarde, France, with a 600 H. P. turbine is driving the machines of his factory and also two Gramme dynamos, from which, by copper conductors placed on poles, the current is led direct to the Edison incandescent lamps used in lighting the town. It is said that, though the illumination is very brilliant, there is room for improvement, a regulator being needed and also arrangements for proper distribution to permit switching individual lamps or collections of lamps on or off. The entire 2,000 H. P. is available and the dynamos should be employed during the day in the generation of currents for domestic consumption or transmission to a distance.

CROWNS OF LIVING LIGHT.—A correspondent visiting Detroit recently, says:—The city is lighted by the electric tower system, each tower a graceful structure of iron, as open to the wind and light as a spider's web. Five Brush lamps at the summit of each lofty tower shine down at night from the outer darkness, looking like so many crowns of living light shining above the city. The view from the Campus Martius up the long vista of Woodward avenue, at night, is very beautiful. The five-pointed crowns of brilliant light, mile after mile along the avenue, far above the houses, and on a level with the weathercocks of the churches, give one the odd impression that Detroit has a celestial lighting apparatus of its own. The Brush company, I was told, agree to light the city for $90,000 a year by its tower system. At the outset the local papers denounced the system as a failure; ridicule was heaped on the innovators, but to-day the praise is as universal as was the denunciation.

PHILADELPHIA COMPANIES IN THE COURTS.—In the Court of Common Pleas, Philadelphia, early this week, was heard argument on the demurrer of the Underground Electric Light and Power Company, to the bill in equity filed by the Electric Light Company. It is claimed by the plaintiff company that the privilege of furnishing electric light to the city was its exclusive right under the act of April 29, 1874, until the stockholders had earned during five years an 8 per cent. dividend. Under an agreement with the Electric Light Company the plaintiff has been lighting the city, but has not yet earned an 8 per cent. dividend. The Court was asked to restrain the use of the streets by the Underground Electric Light and Power Company and the supplying of light to any persons in the city. On the other hand, it is argued that the act of 1874 conferred no exclusive privileges upon the complainants; that such an exclusive privilege cannot be created by implication; and that no privilege is granted unless it be expressed in plain and unequivocal words; that the companies referred to in the act of incorporation were water and gas companies, and that therefore the right of electric companies to make use of the exclusive privileges conferred by this act can only be implied. The matter was held under advisement.

MISCELLANEOUS NOTES.

BURNED OUT.—We regret to hear that the Clark Insulated Wire Co.'s factory, at Bristol, Pa., was burned on Nov. 28. The company have been unfortunate so far as fires are concerned. On June 8, 1883, they were burned out completely, and again in November, 1883, they had a slight fire.

A NEW PROCESS.—In an essay on the electrolysis of fluride, chlorate and perchlorate of silver, Dr. Gore shows that a solution of these salts is readily decomposed by using electrodes of silver and an electric current derived from a single cell composed of zinc and platinum in diluted sulphuric acid.

ELECTRIC PROTECTION.—Letters-patent have been issued incorporating the Holmes Electric Protection Company, with a capital of $100,000, and headquarters at Montreal. The charter members are Edson Holmes and H. C. Room, of New York, and W. F. Boyd, H. C. Ritchie and W. J. Turping, of Montreal.

THE INTERNATIONAL INVENTORS' EXHIBITION.—We are advised by Mr. J. Pierrepont Edwards, the British Consul in this city, that for the convenience of American contributors, the date for the reception of applications for space in the above Exhibition, to take place next year in London, has been finally fixed for January 31, 1885. This will afford American inventors ample time to make their plans and preparations.

M. SENET'S NEW PRIMARY BATTERY.—The French electrician, M. Senet, has constructed a new battery, using double sulphate of ammonia and sesquioxide of iron. In a rectangular cell of wood is a solution of alum and two carbon plates, and water acidulated by one-tenth of sulphuric acid, contained in a porous jar, also a plate case from mercury and zinc melted together. An E. M. F. of 1.7 volts is obtained from this battery, which, it is stated, is very constant. The decomposition supplies sulphuric acid necessary for attacking the zinc, and the depolarization costs only 2c. or 3c. per pound.

GALVANIZING WIRE BY A NEW PROCESS.—The New Haven (Conn.) Wire Co. has lately exhibited and submitted to test a wire galvanized by a new process, in which, it is claimed, by means of a thorough union of the coating with the body of the wire, scaling is prevented, and a smooth, firm surface secured under all circumstances; softness and tensile strength and uniformity of temper are obtained to an extraordinary degree. In samples twisted after galvanizing, the single strand showed 28 and the double strand 48 twists to the lineal foot without a break or flaw in the coating. In this method much less acid is used. To wires for telegraphic or telephonic purposes the process is equally applicable.

THE BALLOON IN HARNESS.—Captain Renard made two more ascents, at Meudon, near Paris, on Nov. 8, for the purpose of testing his apparatus for steering balloons. When clear of all surrounding heights his propeller was put in motion and the speed of the balloon thereby increased. Crossing the Seine below Billancourt Bridge, he headed for Longchamp and came to a full stop a few hundred metres from the river; the speed of the air current was found to be five miles an hour; on again starting the screw the balloon described a half-circle and went straight for and landed at the starting point at the rate, sometimes, of fourteen miles an hour. Another ascent was then made with evolutions right and left, stoppages, startings and a return to the place of departure.

THE INTERNATIONAL MERIDIAN CONFERENCE.—This body of scientists, lately convened in Washington upon the invitation of the Government of the United States, and composed of representatives of twenty-five nations, concluded its labors, as noted in President Arthur's late message, by agreeing, with substantial unanimity, upon the meridian of Greenwich as the starting point whence longitude is to be computed, through 180° eastward and westward, and upon the adoption for all purposes for which it may be found convenient of a universal day, which shall begin at midnight on the initial meridian and whose hours shall be counted from zero up to 24. The formal report of the transactions of this conference will be hereafter transmitted to Congress.

A MAGNIFICENT WORK.—The grand bridge across the Susquehanna River, being built for the Baltimore & Ohio R. R. Co. will be 3,000 feet longer than the bridge of the P., W. & P. Co. at Havre de Grace, the new structure measuring 6,300 feet. One through span of 520 feet, at 90 feet above mean high tide, and four deck spans of 480 feet each, will stretch over the West channel; a through span of 380, and two deck spans, one of 380 feet and one of 520 feet over the East channel. On Garrett Island, dividing the two channels, the approaches and crossings will be iron trestlework. The sub-aqueous work is all to be completed this season, and is much facilitated by the use of the electric light and telephone in the caissons. The opening of the bridge for traffic will not take place before next season.

SECRETARY VS. COMMISSIONER.—Richard H. Hoe and others brought suit for the purpose of obtaining a writ of mandamus to compel the Commissioner of Patents to issue a patent in accordance with his own decision, notwithstanding the fact that said decision had been overruled and reversed upon appeal by the Secretary of the Interior. In the Supreme Court of the United States, Justice Matthews, in a long opinion, decided that an appeal does not lie in patent cases to the Secretary of the Interior; that the Commissioner of Patents has the exclusive right to decide for himself whether or not a patent ought to issue, and the Secretary of the Interior has no authority to review such decision. If the Commissioner errs, the party aggrieved has a statutory remedy, but that remedy is not an appeal to the Secretary.

VULCANIZING INDIA-RUBBER.—Messrs. De la Tour du Breuil Bros., so says the *Chronique Industrielle*, have substituted, in the vulcanization of rubber, a concentrated solution of calcium chloride capable of furnishing a constant temperature of from 150 to 160 degrees, for the generally employed bath of sulphur and steam under pressure. By the new process, which requires no modification of the apparatus at present employed, the iron plate vats, not being exposed to burning, last much longer, and the entire expense is vastly decreased, sulphur costing 200 francs per ton and the calcium chloride but 80 francs. The daily consumption of the chloride is insignificant, while with the sulphur there is continual consumption. By the new plan all injury to the health of workmen is avoided, there is no danger of fire, insurance rates are lower, the consumption of fuel is reduced two-thirds, and the product is of a superior quality with little or no waste.

APPLICATIONS OF POWER.

SUCCESSFUL ELECTRIC RAILWAYS.—The electric railways of Great Britain are proving most satisfactory as transporting agents and as investments. The line at Portrush (Ireland), now in operation one year, has attracted tenfold the usual number of tourists to the Giant's Causeway, and its successful working has been complete, though it runs through most trying country, a succession of heavy gradients and sharp curves for the whole distance, six miles, with little or no level ground. The River Bush, which runs the turbines that furnish the power, never fails in the dryest season. Another road three miles long is being built between Belfast and Dublin, by the Bessbrook Spinning Company, and great interest is manifested by the capitalists and political rulers of the country in its completion. Blackpool is also about to inaugurate a system of electrical tramways, to be completed in the spring, which will, it is promised, surpass everything hitherto attempted. At that fashionable resort, Brighton, the electrical railway there is so crowded that extra cars and trains are necessary. Three distinct applications to construct and exhibit railways at the Exhibition of next year have already been made.

STOCK QUOTATIONS.

Telegraph, telephone and electric light quotations on the New York Stock Exchange, the Boston Exchange, and elsewhere are as follows:

TELEGRAPH.—Am. Cable, b 53, a 58; B. & M., b 2, a 4; Mutual Union, b 12½, a 14; Western Union, b 63¼, a 63½.

TELEPHONE.—Am. Bell, b 270, a 275; Erie, b 20; New England, b 40, a 41.

The tremendous jump in Bell stock is explained elsewhere. There has been a rise of at least 120 points since last June.

ELECTRIC LIGHT.—Market quiet. Few sales.

BUSINESS NOTICES.

CHAFFEE'S PHONOGRAPHIC INSTITUTE, Oswego, N. Y., turns out more good stenographers and procures more good positions for them than any other school in the United States. He gives instruction *by mail*.

THE SECURITY ELECTRIC SIGNAL CO.—The annunciator, guest call and burglar alarm of this company, illustrated and described by us on Nov, 15, is now in use at the Clarenden Hotel, Brooklyn, the Summit House, New York, and Paul Bauer's summer resort at Coney Island. It can be seen, in operation, at the American Institute Fair, this city.

MR. HUGO KAYSER, of 12 Elm street, occupies a floor in that building for the manufacture of all kinds of electrical instruments. He has had great experience in making to order models of electrical and other machinery and instruments of the most delicate nature in which perfect precision is a prime necessity. His specialties are models and experimental work.

A MEDICAL EXPERT'S TESTIMONY.—"Dr. Jerome Kidder's Faradic and Galvanic Batteries have been on the market for many years, and have become thoroughly established in reputation. We take pleasure in offering our experience of many years' use of these batteries, with the most satisfactory results, as evidence of their excellence and value."—*The Quarterly Journal of Inebriety.*

J. H. BUNNELL & CO.—This firm, of 112 Liberty street, have leased the large new building corner of Church and Liberty streets, giving them store windows on two fronts. They will thus be able to make an excellent exhibit of their goods at one of the most important street junctions in the business portion of the city. In this place, additional to their other manufacturing establishments, they will make everything in the line of electric light, telegraph and telephone supplies, telegraph being the specialty. They pay particular attention to making models and to general experimental work. Their Disque battery lately illustrated by us enjoys large sales.

TELEPHONES FOR EXPORT.—The decision of Judge Wallace sustaining the validity of "Bell's" patent is of considerable importance to the Tropical American Telephone Co., which has the sole right to export, to South America, Central America and the West Indies, Bell telephones, Blake transmitters, magneto call-bells and all other patented telephonic instruments, apparatus and supplies, under its exclusive contract with the American Bell Telephone Company, and the company state that, as permanent injunctions will now speedily issue against all manufacturers who have been attempting to ignore these patents, it is well for exporters to understand that if they wish to avoid all liability for infringement they should apply only to the Tropical American Telephone Co., Limited, at 95 Milk street, Boston, for all telephonic instruments and apparatus for export to these countries.

WESTINGHOUSE ENGINES.—Electric lighting continues active and furnishes a large amount of business to engine builders. Among a number of minor sales to private parties, the Westinghouse Machine Company report the following recent sales of their automatic engines: The Lincoln Electric Light Company, of Lincoln, Neb., two engines of 60 horse-power each; the United States Illuminating Company, of Charleston, S. C., five engines of 60 horse-power each; the Toledo Electric Light Company, Toledo, O., one 60 horse-power engine; the Hastings Electric Light Company, of Hastings, Neb., two 35 horse-power engines; the Thomson-Houston Co., of Quincy, Ill., three 60 horse-power engines; the Central Electric Light Company, of Chicago, three engines of 45 horse-power each. The Thomson-Houston Company, of Philadelphia, are also putting a 60 horse-power Westinghouse automatic engine into their shops and test room. C. R. Mabley & Co., clothiers, Detroit, Mich., are increasing their plant of United States incandescent lights. Last spring they put in an outfit driven by two Westinghouse engines of respectively 65 and 8 horse-power each, and have now added another engine of the same make, of 45 horse-power, with corresponding dynamo capacity. The interiors of their stores are lit on the incandescent system, and the outside fronts are brilliantly illuminated by arc lights on both sides of the street.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

Edited by EDWARD P. THOMPSON, M. E., Electrical Expert, 9 Murray Street, New York.

PATENTS DATED NOV. 18, 1884.

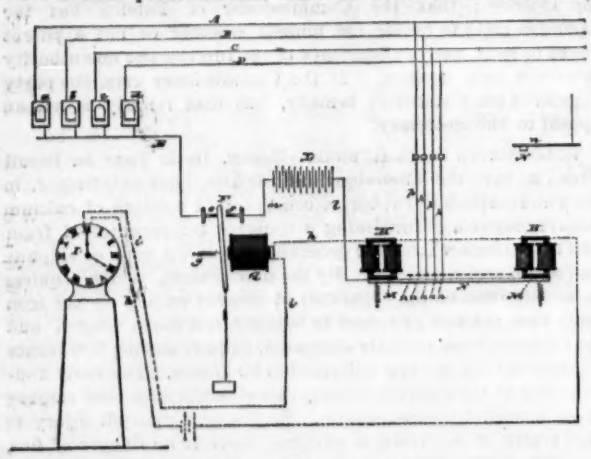
Apparatus for Breaking Electric Circuits; J. L. Horber, Hamburg, Germany..... 308,261

Consists of the combination, with the two overlapping springs connected with opposite ends of a circuit, of a support beneath one of the springs, limiting its downward movement, and the other spring normally tending to move downward out of contact with the first-mentioned spring, and a pivoted cam, beneath the last-mentioned spring, having an abrupt shoulder or edge, and a lever-arm connected to said cam.

Combined Telephone and Time System; R. W. Wilson, New Haven, Conn..... 308,225

In Fig. 1 *I* represents the central office of a telephone system of four circuits, *a b c d* representing the four drops on the annunciator. To these come the lines, respectively, *A B C D*, the line *E* representing the ground.

F is an armature-lever working between the two contacts *e f*, drawn to the contact *e* by a suitable spring *g*. This armature-lever is grounded, as shown, so that when it stands against the contact *e* the circuit is made through the annunciator or switch-board in the usual manner, and the system is worked as a telephone system. Upon the side of the armature-lever *F*, opposite the contact *e*, a magnet *G* is arranged, which, when in circuit, will attract the armature-lever, break the contact *e*, and make the contact *f*. From the magnet *G* one wire *h* runs to the magnets *H*, thence, with a local battery, to the principal or central-office clock *I*. The other line *i* comes from the clock to the magnet. One wire *l* of the battery *L* is in connection with the armatures *M* of the magnets *H*. The other wire *m* from the battery runs to the contact *f*. The clock *I* is provided with any of the many known devices for closing the circuit and holding it closed for a short space of time at predetermined intervals. The device for closing the circuit between the wires *H* and *J* in the clock is not shown; but such devices are too well known to require particular description, it only being essential that there shall be some device in the clock to close the circuit at the said predetermined times. When at such predetermined time the clock closes the circuit,



the armature-lever *F* is instantly attracted to the magnet *G*, taking it from the contact *e*, and bringing it upon the contact *f*, which at once cuts off the ground through the switch-board. At the same time the magnets *H H* attract the said armatures *M*.

As shown, the two armatures *M M* are connected by a bar *N*. Above this bar springs or arms *n* are arranged in numbers corresponding to the telephone circuits or wires *A B C*, and from each of these arms *n* a wire *p*, which may include resistance to equalize the line, runs into connection with the respective lines *A B C D*. These arms or springs *n*, when the circuit through the magnets *H* is broken, stand above the bar *N*; but as that bar rises with the armatures it makes contact with the several springs, as seen in Fig. 2. The current from one pole of the battery *L* passes out through the lines, the other pole being in connection with the armature-lever *F* to the ground. So soon as the clock breaks its circuit at the termination of said short space of time, the armature-lever *F* breaks from the contact *f* and makes with the contact *e* and restores the switch-board into its usual condition, it being understood that the space of time during which the contact is made through *f* is of sufficient duration to give the required signal, or to synchronize the clock, if that be the device by which the time is given.

Dynamo-Electric Machine; H. Short, Denver, Colo..... 308,207

Consists in peculiar form of hollow armature core, with wires wound transversely.

Electric Cable Support or Hanger; A. S. Weaver, Providence, R. I..... 308,220

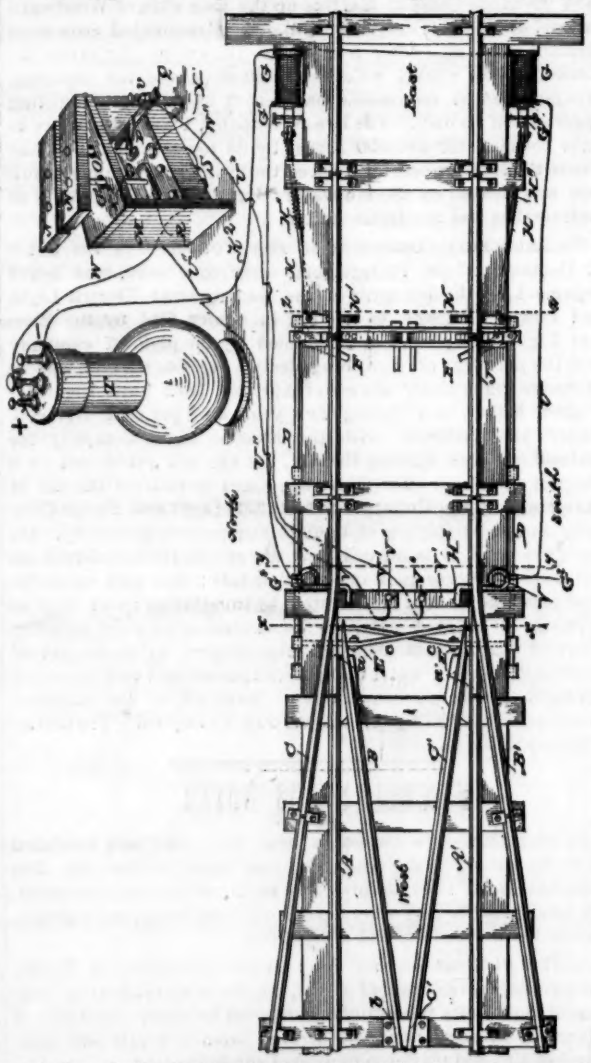
Is cast in one piece of plate metal, slotted and provided with a turn-button, and, besides, it has a series of spurs, to prevent it from slipping on the cable. The metal strip is made to grasp the cable like a band brake.

Electric Railway Signaling Apparatus; B. K. Collenbusch, Soemmerda, Germany, assignor to Dreyse & Collenbusche of same place..... 308,316

Consists of a semaphore which, when set by the attendant to "danger," also sets mechanism by which, in case of the non-observance of the optical signal, a torpedo or other detonating signal is exploded. The means employed for this purpose consist of a switch secured to the semaphore-post and operated simultaneously with the semaphore-arm, said switch being placed in an electric circuit, with a current-reversing device, actuated by the passing train, and with an electro-magnet the armature of which, on being released, actuates an intermediate lever mechanism that drops a weight by which a torpedo is discharged.

Dynamo-Electric Switch; M. Marshall, Jamestown, N. Y..... 308,269

Suppose a train to be coming from east to west, and it shall be desired to switch it off upon the northern siding. The operator will then depress the key *N* of the electro-magnet *S* of his instru-



ment, thus closing the circuit, the effect of this being to convert the electro-magnets *S* and *G* into active magnets. The former will retain its armature and the latter will attract and retain its armature *G''*, thus drawing the pivoted plate *F* under the T-lever *I*. When the train passes, it will depress the raised jointed portion *J* of the track, thus causing the T-lever *I* to strike the plate *F* and vibrate the rock-shaft *D* at the south side of the track, the result of which will be to open the northern siding.

Support for Telephonic Instruments; J. Tregurtha, Malden, Mass., and C. T. Loring, Boston, Mass., Assignors by mesne assignments to the Adjustable Telephone Support Co., of Boston, Mass..... 308,110

The transmitter is rendered capable of adjustment in various ways independent of and distinct from all other adjustments derived from the construction and arrangement of other parts of the support.

Telephone; J. N. McIntire, New York, N. Y.....308,273

Consists in communicating to the diaphragm, through the medium of a column or body of confined air, the sounds of the vocal organs derived from the outer portion of the throat in the vicinity of the larynx.

Thermostat; R. Wilder and J. P. Clark, Portland, Me..... 308,120

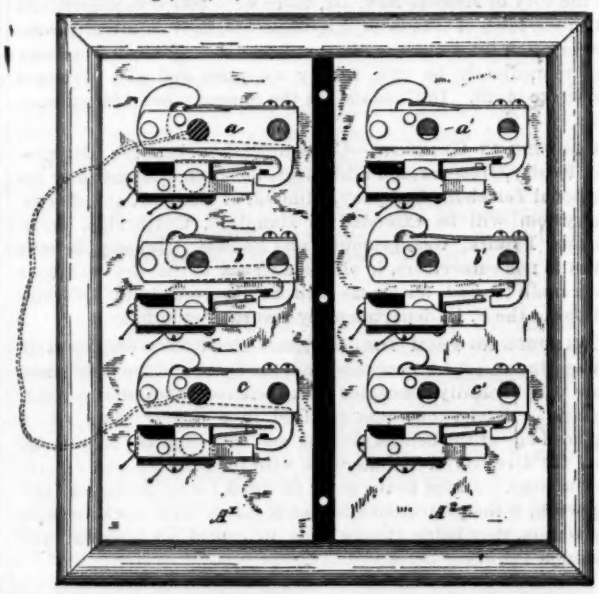
Consists of a concaved diaphragm of metal inclosed within unyielding walls of some non-conducting substance, one pole of an electric battery being constantly in connection with the diaphragm, while the wire of the other pole is so located with reference to the diaphragm that expansion of the diaphragm will cause the convex side of the same to come into connection with such other pole.

Telephone System; C. A. Jackson, Lawrence, Mass., Assignor to David F. Robinson, same place..... 308,165

He discards the central office, and in lieu of the ordinary circuits having their termini massed in such office he employs a number of closed circuits sufficient to enable any subscriber under ordinary circumstances to find some one of them unoccupied, and he runs the entire series of these wires through such subscriber's instrument, and in which, moreover, he furnishes to each subscriber an adjustable or movable switch-board carrying a wire in which is included a receiver and transmitter, and whose ends are connected with conductors secured to such switch-board, these conductors being so arranged as to close the circuit through the wire when the line is broken, thereby enabling any subscriber to put himself in communication with and operate over any circuit-wire.

Multiple Switch-Board for Telephone Exchanges; M. G. Kellogg, Hyde Park, Ill., Assignor by mesne assignments to the Western Electric Co., of Chicago, Ill..... 308,315

In the drawings, Fig. 1, Sheet 1 is a front elevation of two du-



plicate or multiple switch-boards, *A'* and *A²*, each provided with as many switches or terminal plates *a b c* and *a' b' c'* as there are terminal stations. These terminal plates are modified forms of the jack-knife switch, and are adapted to open circuits. Near each terminal plate is placed a circuit-closer in a try-circuit.

Telephone Exchange System; J. P. Freeman, Chicago, Ill..... 308,248

Consists of the combination of alternate conducting and non-conducting parallel bars arranged in benches or steps. By means of suitable colors representing like conducting bars arranged as described in steps, confusion is avoided in intercommunication by the operator.

Thermostat; A. W. Tubbs, Jersey City, N. J..... 308,293

Consists in constructing an instrument in substantially the following manner: A stout metallic inclosing case is provided with a thin yielding corrugated diaphragm soldered tightly at its edges to the inner surface of the case, thus forming a chamber which is designed to contain a small quantity of volatile fluid. It is evident that when the chamber has thus been slightly filled with a few drops of volatile fluid—such, for instance, as alcohol—and then subjected to heat, the expansion resulting therefrom will cause the flexible diaphragm to be thrown outward, and the degree to which it will be thus pressed outward will depend upon the amount of heat to which it is subjected.

The electric circuit is thus completed to sound the alarm at a distant point.